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EDITED BY J. McKEEN CATTELL

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EDITED BY J. McKEEN CATTELL

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THE
POPULAR SCIENCE
MONTHLY.

MARCH, 1911

EHRLICH'S SPECIFIC THERAPEUTICS IN RELATION TO SCIENTIFIC METHOD

By FIELDING H. GARRISON, M.D.

ARMY MEDICAL MUSEUM, WASHINGTON, D. C.

AN almost negligible mortality ratio of 12 deaths in 12,000 cases of syphilis treated by "606" is the record which Professor Ehrlich was able to produce at the Königsberg meeting of German scientists,[1] and in these fatalities, accidental circumstances like shock, heart-failure and extreme debility were coefficients of greater moment than the acid and toxic nature of the remedy itself. As compared with the high ratio of successful treatment—probably towards 90 per cent. or more—the result is significant and striking. As the administration of "606" by injection is exceedingly painful in the first stages, Ehrlich compares it with operative surgery in that it can never be given without a certain risk in desperate cases, yet is better worth trying than to leave the patient to suffer or die. Its use is interdicted in disease of the heart, blood vessels or kidneys or in advanced stages of nervous disease, and, with characteristic reserve and caution, its author declines to make any premature claims regarding the cure of the disease with a single dose, although this is the avowed and ultimate of his *therapia sterilisans*

[1] As reported in *Die Heilkunde*, Berlin, October, 1910, 357. For a fuller account, see the transactions of the Deutsche Naturforscher und Aerzte as reported in the *Deutsche medizinische Wochenschrift* (reprinted by G. Thieme, Leipzig, 1910). Subsequent statistics show that the mortality ratio remains about one in 1,000 cases (.01 per cent.). It may be said that expression "606" is not a trade name, but a convenient abbreviation for the successful term and end of a series of 606 new compounds made and tested. Chemically "606" is the hydrochlorate of dioxydiamido-arsenobenzol, and was first tried out by Ehrlich's Japanese assistant, Dr. S. Hata. On account of its extreme acidity, it is now neutralized with caustic soda and administered as the sodium salt, the empirical formula of which might be written $C_{12}H_{10}O_2N_2Na_2As_2$. It has recently been patented as "salvarsan."

magna. Before any conclusions can be formulated, the after-effects of the remedy must be studied, he says, for some months running, possibly a year or more. Will "606" permanently abort or check an attack of syphilis, or will it, like a drastic silver nitrate treatment in gonorrhœa, cause some of the pathogenic organisms to burrow into the deep tissues, only to crop out as an embarrassing recrudescence later on? Will it have any effect upon the posterity of syphilitics or upon those strange parasyphilitic affections, locomotor ataxia and general paralysis? Will it produce a generation of paretics and ataxics as some think mercury does? These and similar questions that suggest themselves can only be resolved by a study of the treated cases over long periods of time. The fact that suckling infants are cured after their mothers have received the injection would argue, Ehrlich thinks, that something like antibodies are formed in the maternal milk, indicating that "606" acts like a true antitoxin. This would seem to be borne out by the disappearance of the Wassermann serodiagnostic reaction shortly after the injection is given. I am informed by Captain Charles F. Craig, of the Army Medical Department, that in 33 United States soldiers recently treated with "606" (medium doses of 0.6 gram), the syphilitic lesions and the Wassermann reaction disappeared in 28 cases during periods of time ranging from five days to about two months, the men being returned to duty as cured.[2] Statistical results like these are now mounting up by the hundreds in the medical journals of the world, and if the effects of the drug are permanent it is probable that syphilis will become, in due course, a rare disease in civilized communities. There are some who have still enough of "*odium theologicum*" in their composition to think this disease a sort of divine punishment for the social evil, and that its suppression would imply an inevitable increase in immorality. But morality and immorality are too much the resultant of a conflict between innate disposition and social or ethical forces to be appreciably influenced by discoveries in therapeutics. These bigoted souls may take comfort in the fact that "606" is a simple chemical remedy, acting like quinine in malarial fever. It protects the innocent—the wives and children of the infected man—but, if it spares the sinner for the present, it holds out no alluring prospects for vicious indulgence in the future. "606" does not confer immunity from subsequent infection.

The scientific career of the remarkable man to whom medicine owes so much and who himself owes so little to university training is a striking example of the self-reliance and autodidactic tendencies that

[2] In the circular of instructions for the administration of "606" issued by the Surgeon General of the U. S. Army (December 13, 1910), it is directed that for present routine work among soldiers the medium dose of 0.4–0.6 gm. should be given. This may probably be increased to 1 gm. later on, when the after-effects of the remedy are ascertained.

sometimes accompany ability of the highest order. As a student, Ehrlich bore out President Eliot's theory that any young man who has real capacity usually has a better inkling of its extent, if not of its limitations, than his elders can teach him. Age and experience may perhaps indicate what youth can't do, but they have no power of predicting what it can do. It is related that when Robert Koch was once visiting the Breslau laboratories, a young student working at a table covered with staining materials was pointed out to him, with the remark: "There is our little Ehrlich. He is a first-rate stainer of tissues, but he will never pass his examinations."[3] The prediction was true. Ehrlich got his degree by courtesy, on the strength of his well-known discoveries in the histology of the blood; but doubtless his academic sponsors serenely followed the example of Kant, who, in lecturing, addressed himself to students of mean average intellect only, on the assumption that the blockheads were beyond human help, while the geniuses could take care of themselves. The young Ehrlich easily made himself recognized as a true-born scientific genius, but his example will scarcely save less careful or more luckless students from being plucked at their final examinations.

Although for practical use, Ehrlich's researches in synthetic chemistry rank near to those of Emil Fischer, he is a true Asclepiad, and his principal aim has always been to improve the diagnosis and treatment of disease. Nearly all his results are of fundamental importance for actual medicine and they are a long list. We can imagine some awarder of a Copley medal or Nobel prize recounting them: First, the improved methods of drying and fixing blood smears by heat and the staining methods which have become such a feature in recent diagnosis, notably the tri-acid stain, the fuchsine stain for tubercle bacilli and the method of intra-vital staining, the first step towards getting in touch with what is going on inside the living cell; then his discovery of five new constituents of the blood which have become basic principles in modern diagnosis; his important study of the oxygen requirements of a living organism; his diazo-test for the urine in typhoid fever; his demonstration that animals can be quantitatively immunized against the effects of vegetable poisons like abrin and ricin, as well as against the toxins of vegetable parasites; and conversely, that animal parasites have the power of immunizing themselves and their descendants against the action of drugs; his improvement of Behring's diphtheria antitoxin and his establishment of an international standard of purity for the same; his side chain theory of immunity, which led at once to such brilliant results as the Wassermann method of serodiagnosis and (in medical jurisprudence) to the precipitin tests for blood-stains (Bordet-Uhlenhuth) and the cobra-venom test for insanity (Much-Holtzmann);

[3] The anecdote is given by the late Dr. Christian A. Herter in *Jour. Am. Med. Assoc.*, Chicago, 1910, LIV., 428.

his studies in isolysins which inaugurate a physiology peculiar to the individual as opposed to the normal physiology of the species; his idea of a canonical study of the blood-serum in health and disease, so that a norm or "blood-canon" for the investigation of new or unknown conditions may be available; his demonstration that cancer may be changed into sarcoma by successive inoculations; that the growth of cancer in an animal body depends upon the presence of certain food-stuffs in that body; finally the gigantic labors involved in building up hundreds of new compounds and testing them as remedies for the two great groups of parasitic diseases, the spirilloses and the trypanosomioses, his prospective success being one of the greatest triumphs of the method of "trial and error" on record. Surely a career in scientific medicine only matched in recent times by those of Pasteur, Helmholtz, Koch and Lister.

To the orthodox chemist, who works by rule and formula, Ehrlich's experimental methods might seem mere haphazard "test-tubing," and he himself has jestingly referred to his laboratory procedure as "*Spielchemie,*" an epithet which well describes the experimentation that results from the free play of a singularly acute mind. Some of his admirers have even gone so far as to say that he declines to work quantitatively. Although his own statement (in the Harben lectures) is just to the opposite effect—and all experiment that seeks the general law behind related facts is obviously quantitative in its intention—it is quite true that Ehrlich has steadfastly declined to follow Arrhenius in applying the quantitative methods of physical chemistry to the unknown entities of immunity reactions. "I have always emphasized the chemical nature of the reaction," he says, only "the formulas devised by Arrhenius and Madsen for the reactions of toxins and antitoxins explain absolutely nothing. Even in particularly favorable cases they can merely represent experimental results in the form of interpolation formulas."[4] In Ehrlich's view, the mistake made by the distinguished Swedish physicist lies in the assumption that toxins and antitoxins can be treated mathematically as simple indivisible substances, whereas there is unimpeachable evidence of their dual and multiple nature—that they can be split up into labile components of such extreme complexity as to have, so far, defied ultimate analysis. Under these conditions assumed constants become inevitably dependent variables and the physical chemist is dealing with the shifting evanescent aspects of substance in the labile state. The careful quantitative work of such a competent experimenter as Dr. W. H. Manwaring[5] has shown that, with the knowledge at present available, physico-chemical measure-

[4] Ehrlich, "Collected Studies in Immunity," New York, 1906, 578.

[5] Manwaring, *Jour. Infect. Dis.*, Chicago, 1907, IV., 219–222; *Jour. Biol. Chem.*, New York, 1907–8, III., 387–389; *Brit. Med. Jour.*, London, 1906, II., 1542–1547.

ment of the constantly variable constants of immunity reactions is like computing the dynamics of *ignes fatui.* Even if the ultimate formulæ of toxins or protoplasm could be ascertained in the laboratory, as in the case of hemoglobin or urea, it would tell chemists nothing about what they are in the living body. The ultimate phenomena of life and death are still (in Spinoza's classic phrase) of a kind *" quæ nullo numero explicari possunt,"* and Ehrlich's theory, as he predicted in his Baltimore lectures, has been deeply enough rooted in experimental fact to " withstand the Northern storms." In a most interesting paper in THE POPULAR SCIENCE MONTHLY,[6] Dr. A. F. A. King, of Washington, has thrown into relief the all-important point that the essential feature of a living organism is the limiting, peripheral, semiporous membrane, skin or sheath which, like the semipermeable membrane in physics, invests and insulates it, preventing it from dissipating its energy, except sparingly and under definite conditions. Detached from the investing semipermeable membrane, Dr. King holds that cellular protoplasm is " neither alive nor dead but between the two." The telling feature in Ehrlich's attack upon disease is the unique way in which he has visualized and dealt with those basic border-line substances which, *in vitro,* if not *in vivo,* are " neither alive nor dead, but between the two." He has clearly seen that the mathematical expressions for such labile complexes as protoplasm or toxins do not come under Sir William Hamilton's category of " real numbers." They may be vectorial quantities or relations like those of electrical science, and might be represented specially, graphically, vectorially or stereochemically to the mind's eye as Ehrlich has succeeded in doing; or they might be vaguely formulated as qualitative relations by the differential calculus. Quantities in the fixed arithmetical sense they are surely not. Ehrlich's method might be called a qualitative way of approaching apparently quantitative problems of extreme complexity, a sort of rough calculus of variations carried out in the laboratory under conditions in which the variables are well-nigh legion. His success has been due to his unrivaled knowledge of the intravital and distributive relations of different drugs, particularly of dye-stuffs and, on the theoretical side, to what he calls his " chemicoplastic imagination." Such a feat of fantasy as his side-chain theory is not only solidly built up on experimental fact, but is intimately concerned with the architectonics of stereochemical formulæ and with certain space-intuitions which are coming to be pretty generally accepted by organic chemists to-day. So we find Professor H. E. Armstrong, of London, stating at the Winnipeg meeting of the British Association (1910)[7] that for the modern chemist " the tetrahedron is the symbol of the functional activities of carbon," that " even the paraffins are not to be visualized as so many ducks strung upon a ram-

[6] THE POPULAR SCIENCE MONTHLY, September, 1909, 289–296.

[7] Rep. Brit. Ass. Adv. Sc., 1909, London, 1910, 438, 446.

rod Munchhausen fashion, but as forming curls, according to the natural set of affinities"; and that "protoplasm, in fact, may be pictured as made up of a large number of curls, like a judge's wig—all in intercommunication through some center, connected here and there, perhaps, by lateral bonds of union." Ehrlich's conception of the molecule of functionally active protoplasm as consisting of a fundamental nucleus plus a large number of different chemical receptors or side chains is obviously at one with this stereochemical picture and he began to apply it as far back as 1885, in his studies on the oxygen requirements of the organism.[8] In this important work he makes it clear that what he terms "color-analytics" (*farbenanalytische Studien*) is the most accessible way of investigating the intimate mechanism of intracellular or protoplasmic chemistry. He was early impressed (or as he himself puts it "obsessed") with the idea of a selective and distributive relation between definite chemical substances and definite body-tissues of the kind which chemists are agreed to describe as special "affinity."[9] Starting with Hoppe-Seyler's observation that the emission and absorption of light in chlorophyll is accomplished, not by the entire chlorophyll molecule, but by certain specialized groups of atoms in it, he proceeds to outline the germinal idea of his side-chain theory, viz., that in the living cell the peripheral nutritive and excretory processes are accomplished by specialized atom groups of the protoplasmic molecule—the chemoreceptors. Suppose some extraneous substance, *e. g.*, a food, a drug, or a poison, to be brought in juxtaposition with these peripheral receptive side-chains. Expressed in terms of thermodynamic chemistry we have the familiar Gibbsian problem in chemical equilibrium which Roozeboom has so picturesquely described as "the sociology of chemical substances." If the chemical and thermal relation of the substances is such that they will immediately and definitely combine, we shall have chemical and thermodynamic equilibrium; but if the effect of the external substance is stimulative or catalytic, the living protoplasm, having greater chemical energy and higher chemical potentiality, will expel a certain portion of itself to combine with the latter. Expressed in terms of stereochemistry, equilibrium is accomplished by the chemical

[8] "Das Sauerstoff-Bedürfniss des Organismus: Eine farbenanalytische Studie," Berlin, p. 885.

[9] It is interesting to note that the quasi-sexual concept of "chemical affinity" was first employed in science by a physician, Hermann Boerhaave ("Elementa chemiæ," Lugd. Bat., 1732, 677). Boerhaave says that when aqua regia dissolves gold the relation of the solvent to the solute is such that "each loves, unites with and holds the other" (*amat, unit, retinet*). The expression gained currency through its employment by Geoffroy and other French chemists to displace the old Newtonian concept of "attraction." (See Whewell's "History of Scientific Ideas," London, 1858, II., 15–20.) When Wagner's "Tristan und Isolde" was first produced, the symbolism of the philtre in the opera was chaffed by the humorists of the day as an instance of "chemische Liebe."

bonds of the receptor atom groups and the corresponding bonds of the external groups being so related structurally that they dovetail, or in Emil Fischer's well-known analogy, fit each other as lock and key. The extraneous substance is thus in Ehrlich's own terminology "fixed," anchored or bound by the special chemoreceptor groups or the products they throw out. Now what we know of the dynamics of cellular pathology is summed up in Carl Weigert's generalization that the amount of repair of an injured or diseased tissue is usually in excess of what is required, provided the original injury is not too great. When a cell is attacked by a toxin or poison the receptor atom groups will, unless immediately overwhelmed, gradually acquire the power of throwing into the blood detached portions or products of themselves—the antitoxins—and these new side-chains float in the neighborhood of the cell, like so many battleships to protect it from injury. Ehrlich compares these antibodies to lightning rods which draw away the destructive elements to themselves. When administered as therapeutic injections he compares them to "charmed bullets which strike only those objects for whose destruction they have been produced." This is the gist of Ehrlich's theory of immunity and its central idea of a special affinity between drugs and tissues has been the center of gravity of Ehrlich's life work. The unusual terminology which he employs—the various toxophores, toxoids, toxones, amboceptors, haptines, etc.—are simply so many tags or labels affixed to designate complex protoplasmic products of unknown composition with the action of which he has become familiar through long process of experiment. The importance of these imaginative concepts, Ehrlich insists, is in their "heuristic value." How great this heuristic value is, how it has served as an inductive principle in seeking the essentials through the labyrinth of accidentals, is seen in such a triumph of synthesis as the Wassermann method for the serodiagnosis of specific infections. Concerning this discovery Wassermann says that although the side-chain theory was for years an apple of discord among bacteriologists, a thing to look upon askance, yet he could never have hit upon so special a test without Ehrlich's imaginative picture of the mechanism of disease as a guide in his experiments.[10] Protected by parallel control tests with known syphilitic and non-syphilitic bloods, this mode of diagnosis is practically infallible, even in ataxia and paresis. As an important step forward, it changed the whole aspect of those puzzling cases of immunity from syphilis which are known as Colles's law and Profeta's law. By Colles's law a syphilitic

[10] "Die Seitenkettentheorie, der jahrelange Zankapfel im bakteriologischen Lager, hat besonders dazu geführt, Ehrlich in manchem medizinischen Kreisen als 'Theoretiker' auf dem Immunitätsgebiete zu betrachten, und den 'praktischen' Wert der Seitenkettentheorie über die Achsel anzusehen. Demgegenüber kann der Schreiber dieser Zeilen nur sagen dass man ohne die Lehren Ehrlichs beispielweise niemals die Serodiagnostik der Syphilis hätte finden können," A. Wassermann, *München. med. Wchnschr.*, 1909, LVI., 247.

child may result from a syphilitic father and an apparently healthy mother, the mother's immunity being shown by the speedy infection of a healthy wet-nurse from the child's lips, while she herself nurses with impunity. Conversely, Profeta's law asserts that an apparently healthy child may sometimes be born of a syphilitic mother (and father), in which case it may be suckled by either the mother or a syphilitic wet-nurse without danger of infection. In either case examination of the blood has demonstrated the existence of the parasites as well as the permanence of the Wassermann reaction, in the mother's blood in the first instance, in the child's in the second. It became evident, from facts of this kind, that immunity from protozoan infection (animal parasites) is not the same thing as immunity from bacterial infection (vegetable parasites). In the latter case the immunity is derived from the antitoxic products of the bacteria themselves. In the case of the animal parasites, we know nothing of the chemical sources of infection and immunity. As a matter of pure speculation, perhaps the immune mother in Colles's law and the immune child in Profeta's law may, like the bacillus carriers of typhoid fever, come under Ehrlich's immunity of the first order (natural immunity), in which the sensitive receptors have either become worn out and insensitive or no longer exist as such. Theorizing aside, the practical outcome of these details was the evident impossibility of curing parasitic diseases by special antitoxins or vaccines, and the practical necessity of finding chemical specifics which would destroy the parasites as quinine does the malarial plasmodium. The next step towards a rational chemotherapy was Ehrlich's discovery that when mice infected with trypanosomes are treated with specific dyes like trypan red in doses that fall short of complete sterilization by some assignable quantity, a race of trypanosomes can be gradually bred which will prove permanently "fast," or resistant to the effects of the drug. The power of parasites to immunize themselves and their descendants against the effect of destructive poisons led Ehrlich to his next move in attempting to checkmate them—the idea of sterilizing the patient's body *uno ictu* ("mit einem Schlag") by a single dose of medicine. It was "upon this hint that he spake" in formulating his *therapia sterilisans magna* and we are now in a position to appreciate the value of his discoveries in pharmacodynamics.

In his Harben lectures before the Royal Institute of Public Health in 1907 Ehrlich stated his conviction that pharmacology, toxicology and therapeutics are "the most important branches of medicine." In other words, he believes that the chief end of the physician is to get his patients well. Self-evident as this proposition is, it has a certain paradoxical novelty when we consider the dominance of ætiological studies (pathology and bacteriology) through the last half of the nineteenth century and the apparent *débâcle* of drug therapy which attended the rise of experimental pharmacodynamics. In such natural remedies as

heat, light, electricity, hydrotherapy, climate, dietetics, hypnotism and psychotherapy, out-door exercise and simple living, the physician has many strings to his bow, apart from the more special arms of treatment like operative surgery, ophthalmology, orthopædics, etc. In respect of drugs, it is perhaps no exaggeration to say that scarcely more than a double baker's dozen are strictly reliable. Even the average practitioner of to-day will admit that in regard to general treatment of disease with drugs we are almost where we were over 2,000 years ago. Among the greater Greeks, the divine Hippocrates created surgical diagnosis and taught physicians how to group symptoms and to describe different diseases; Theophrastus Eresius, the friend and pupil of Aristotle, was the founder of scientific botany; Dioscorides made the first materia medica and Galen, the father of the experimental idea, taught the Romans how to apply it. Of the two great founders of European medicine, Galen was the abler and keener therapist, but inclined to brag about his cures. Hippocrates, who told of his failures also, was the truer clinician. The complicated and elaborate polypharmacy which Galen imposed upon medicine was exaggerated into the most filthy extremes during the Byzantine period and was further enlarged by the superior chemical knowledge of the Saracens. To this day, what Osler calls "the heavy hand of the Arabian" is sensed in the enormous bulk of our pharmacopœias. After the Revival of Learning and during the Renaissance period, the chief concern of medicine was the development of anatomy and surgery, and while a few original spirits like Saliceto, Mondeville and John of Arderne were good healers, yet down through the eighteenth century, treatment was largely an affair of lengthy "gunshot prescriptions," compounded of multifarious ingredients on the hit-or-miss principle, well-deserving of Mark Twain's comment "serve with a shovel." The tendencies of this picturesque therapy, founded upon the "doctrine of signatures," have been very prettily rhymed in the *envoy* to Kipling's recent story about old Nicholas Culpeper, the most famous of the seventeenth century quacksalvers, herb-doctors and "judicial astrologers":

Excellent herbs had our fathers of old—
Excellent herbs to ease their pain—
Alexanders and Marigold,
Eyebright, Orris and Elecampane,
Basil, Rocket, Valerian, Rue,
(Almost singing themselves they run),
Vervain, Dittany, Call-me-to-you—
Cowslip, Melilot, Rose of the Sun.
Anything green that grew out of the mould
Was an excellent herb to our fathers of old

. . . . . .

Wonderful little when all is said,
Wonderful little our fathers knew,
Half their remedies cured you dead—

Most of their teaching was quite untrue—
Look at the stars when a patient is ill,
(Dirt has nothing to do with disease)—
Bleed and blister as much as you will,
Bleed and blister as much as you please.[11]

Paracelsus, who originated the treatment of syphilis with mercurials, made a brave stand for chemical therapeutics in the sixteenth century, but there could be no scientific treatment of disease without accurate knowledge of physiology, pathology and clinical diagnosis. Harvey's physical demonstration of the circulation of the blood awoke experimental physiology from the sleep of fifteen centuries, but had to wait upon the specialization of laboratory physics and chemistry for its further advancement. Modern chemistry began with Priestley's discovery of oxygen and Lavoisier's introduction of the balance. Physical diagnosis began to be a science with the inventions and discoveries of Auenbrugger (percussion), Laennec (stethoscope and mediate auscultation), Louis (statistical interpretation), Skoda (physics of chest diseases), and Wunderlich (clinical thermometry). The therapeutics of ordinary ailments became more refined but the treatment of specific infections could not be ætiological before the development of cellular pathology by Virchow, of bacteriology by Pasteur and Koch, of medical parasitology by Manson, Laveran, Ross, Reed, Stiles and Schaudinn. In the eighteenth century medicine had been an affair of theories and systems, and in each instance the treatment was dominated by the particular view of the nature of disease—Boerhaave's, Haller's, Brown's, Cullen's or Hahnemann's. Homœopathy,[12] the most dogmatic and fantastic of these, illustrates the trend of drug therapy for over a hundred years—the tendency to treat symptoms rather than to remove the cause. About the middle of the nineteenth century we come to the so-called "therapeutic nihilism" of Vienna, in which practise degenerated into simple diagnosis. This was mainly due to the influence and example of Skoda, an unrivalled diagnostician, but incidentally a whimsical, lop-sided Czech, who claimed that although we can diagnose and describe disease, "we dare not expect by any means to cure it." Great as Skoda's scientific attainments were, his influence upon therapeutics was wholly pernicious, and it became a sort of by-word in Vienna that to be auscultated by Skoda was a possible prelude to being

[11] Rudyard Kipling, "Rewards and Fairies," Doubleday, Page & Co., New York, 1910, pp. 281, 282.

[12] Although Hahnemann's "Organon" was published in 1810, he began to practise about 1799, and his theory of therapeutics, with its attempt at systematization, is fairly characteristic of the eighteenth century. Homœopathy has had some good effect upon therapeutics in lowering the scale of dosage of drugs. In the inscription upon the pedestal of Hahnemann's statue at Washington, the original dogmatic universal affirmative "Similia similibus curantur" has been softened down to the tentative implications of the subjunctive mood: "Similia similibus *curentur*."

autopsied by Rokitansky. A diagnosis confirmed by a post-mortem became a too frequently attainable ideal and the physician of the day went far towards being the "petulant scientific coxcomb" of Mr. Bernard Shaw's aversion. This sterile complacency went even further, for we read in Baas that there were deaf physicians in Vienna who could not use the stethoscope but who presumably traded upon the Skodæsque dogma that there is no treatment for disease. Meanwhile organic chemistry was forging ahead at a rate which to Helmholtz "did not seem quite rational." The science of the coal-tar products brought great numbers of new drugs into play and pharmacology became more and more exact. Experimental pharmacodynamics, however, is a plant of very recent growth, the work of such men as Schmiedeberg, Buchheim, Traube, Brunton and Cushny. After reading the text-book of Schmiedeberg's brilliant pupil Cushny[13] we get such a poor idea of the bulky pharmacopœias of recent date, that the remains of the sifting process seem very like the stock in trade of Romeo's starving apothecary—

> **A beggarly account of empty boxes**
> **Green earthen pots, bladders and musty seeds,**
> **Remnants of pack thread and old cakes of roses.**

"The period of constructive pharmacology," says Cushny, "has scarcely dawned: at present its chief function is destructive and critical," and he points out that remedies "generally employed may be numerated in units where they were once counted in scores." The effect of this destructive criticism upon "pharmacologic fetishisms" (as Barton calls them) is seen in the gradually changing attitude of the medical profession towards a work like Osler's "Practice," which is not only the best book on the subject in English, but also the best abused, on account of the author's very conservative feeling about drug therapeutics. As a matter of fact, Professor Osler gives with lucid, scientific precision all that can be done for a given disease; when it comes to general drugging, he says that such and such remedies may be tried: he does not guarantee that they will cure. Similarly, if we follow the teaching of one of the most eminent of recent French clinicians, the lamented Huchard, actual drug therapy may be limited to some twenty remedies or groups of remedies (*"La thérapeutique en vingt medicaments"*),[14] viz.: opium, mercury, quinine, nux vomica, digitalis, arsenic, phosphorus, ergot, belladonna, chloral, bismuth, the bromides, the hypnotics, the purgatives, the antiseptics, the anæsthetics, the antipyretics, the

[13] Cushny's "Pharmacology" (5th ed., Philadelphia, 1910) is dedicated to Schmiedeberg, "*dem Meister vom Schüler gewidmet.*" For an interesting account of recent aspects of the subject see the two papers on "Pharmacologic Fetishisms," by Dr. Wilfred M. Barton in *Jour. Am. Med. Assoc.*, Chicago, 1909, LII., 1557–1560; 1910, LV., 284–287.

[14] By Henri Huchard and Ch. Fiessinger, Paris, 1910.

nitrites, the sera and vaccines, the animal extracts. In this list it will be noted that of the few actual drugs left from the vast accumulation of centuries, nearly every one has a specific intention.

The idea of specificity in the treatment of disease had its origin in Jenner's immortal discovery of preventive inoculation, but first began to attain its full growth with the development of the bacterial theory of infection. Pasteur's preventive inoculations in anthrax and hydrophobia made a good start in the right direction, but the temporary failure of Koch's tuberculin showed that the path was a perilous and thorny one even for a man of genius. Behring's discovery of antitoxins and the success of his diphtheria antitoxin opened out new aspects of the subject, but pure serotherapy with stock antitoxins has been so far effective only in diphtheria, tetanus and serpent poisoning. The work of Sir Almroth Wright and his followers made it clear that antitoxic and antibacterial immunity are two entirely different things. In the latter case, the immunity or cure is not brought about by the dovetailing of the chemical bonds of toxins and antitoxins, but by stimulating the tissues to produce opsonic or sauce-like materials which make the pathogenic organisms more easily absorbable by the white blood corpuscles. This is the phagocytosis of Metchnikoff and is best attained by the injection of dead cultures or vaccines of the organisms producing the disease. Vaccinotherapy has been so far successful in such blood poisonings as puerperal septicæmia or furunculosis, in gonorrhœal rheumatism, and particularly in preventive inoculations against typhoid fever. In such a toxæmia as puerperal fever, the infection may be due to many different bacteria and here the treatment reaches such a high degree of specificity that it becomes, in effect, individual and autogenous, the vaccines being prepared from the blood of the lying-in woman to attain the Ehrlich ideal of "charmed bullets." In typhoid fever, the success in the case of some 14,000 United States soldiers recently vaccinated against the disease under the direction of Major F. F. Russell, has been such that Major Russell thinks the time has come when this preventive measure should be extended to the civil population also.[15] The discovery that a large number of specific infections—notably malarial fever, sleeping sickness, relapsing fever, hook-worm infection and syphilis—are due to animal parasites, revealed still another class of diseases requiring specific treatment—a class which probably includes cancer, rheumatic fever, smallpox, yellow fever, pellagra, hydrophobia and most diseases of the skin. Ehrlich was late in entering this field of specific therapeutics, but he immediately began to dominate it, for it was he who put the treatment of protozoan infection upon a scientific basis. Having discovered that animal parasites can immunize themselves against the action of

[15] *Boston Med. and Surg. Journal*, Jan. 5, 1911, 1–8.

drugs, his problem has been in each case to find a protoplasmic poison of such nature that it will not injure the patient's tissues, but will sterilize his body against the parasites in one or two injections. Success in finding such drugs must obviously depend upon an intimate knowledge of the relation between chemical structure and pharmacodynamic action and, in this obscure matter, Ehrlich has had at his fingers' ends a fund of practical information that is almost unprecedented. It is known that the physiological action of the organic radical in a drug molecule is the same, no matter what combination it enters into, while the inert parts of the molecule may alter the degree, but not the kind of action. Thus the anesthetic effect of cocaine or its derivatives is due to the amido-benzoic acid group in the cocaine molecule. Again the most toxic compounds are those which most rapidly liberate the active atom group in the molecule by decomposition, as in the case of many coal-tar products. Building upon facts of this kind, Ehrlich has in a surprisingly short time turned out definite effective remedies like methylene blue for quartan fever, trypan red in bovine piroplasmosis (Texas fever), arsenophenylglycine for the trypanosomiases (sleeping sickness in man, surra and mal de caderas in horses), dioxydiamidoarsenobenzol or "606" for the spirilloses (syphilis and relapsing fever). The technical and structural details of this wonderful piece of chemical research have been very thoroughly and ably described in a recent number of *Science* by Dr. H. Schweitzer[16] to which our readers may be referred. One instance of the extreme specialization of Ehrlich's chemotherapeutic knowledge may be quoted, his theorem that effective remedies for sleeping sickness must be "tetrazo colors derived from naphthalen disulpho-acids with the sulpho-groups in the 3.6 position."[17] The labors involved in building up and trying out several hundred of these new compounds was enormous, and in order to facilitate a system of exclusion, Ehrlich utilized his discovery of parasitic immunity against drugs in his device of a "*cribrum therapeuticum*" or therapeutic sieve, which will immediately classify any new chemotherapeutic substance in regard to its destructive effects upon pathogenic parasites. This is accomplished by rendering different parasites resistant to various drugs (*e. g.*, fuchsine or atoxyl) through many generations, until finally a "strain" or breed is produced that is definitely fuchsine-fast, atoxyl-fast, etc. When a new drug is tried upon these different resistant strains, its pharmacodynamic status can be ascertained at once. If it destroys all the resistant strains it clearly belongs to a new and untried group. Ehrlich has even succeeded in cultivating strains of trypanosomes each of them re-

[16] "Ehrlich's Chemotherapy—A New Science," by Dr. H. Schweitzer, *Science*, December 9, 1910, 809–823.

[17] *Ibid.*, 815.

sistant to the action of several drugs, which simplifies such work still further. In thus employing the unstable coal-tar products to destroy organisms made up of labile protoplasm, Ehrlich has opened up an entirely new field of therapeutics. As Morgagni, the first pathologist, treated of the seats and causes of disease (*De sedibus et causis morborum*), so Ehrlich has sought (he claims) to gain a fuller knowledge of the distributive and local causal relations of the finest mechanism of drugs, *de sedibus et causis pharmacorum.*[18]

In deploying this vast chemical knowledge against protozoan disease Ehrlich has been likened to a general who aims to take a fort by investing it on all sides. In the other important respect he resembles a great commander—in the possession of an imagination lively and keen enough to figure out the enemy's possible movements as the first step towards checkmating him. The true fighter always respects his adversary, and Ehrlich, who, in profile, looks so much like Thomas Carlyle, has taught physicians to have a very wholesome respect for their adversary, the disease germ. He has seen and demonstrated that the parasites of disease can protect themselves against man's attacks, that in this respect they are as wary and fertile in resource as we. In the future history of medicine he will have his high place as the most original thinker of his time in regard to the nature of infectious disease, as a leader in synthetic chemistry, and as a foremost champion in humanity's *"Kulturkampf gegen den Tod."*

[18] Ehrlich, Harben Lectures ("Experimental Researches in Specific Therapeutics"), London, 1908, 88.

THE DISCIPLINARY VALUE OF GEOGRAPHY

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Part II. The Art of Presentation

Oral and Printed Presentation.—At the close of a study, an investigator naturally wishes to make report of his results and thus to submit them to the criticism of others than himself and his immediate teachers. He has then to consider whether the report shall take the form of an oral statement before a conference of his associates, or a written essay to be printed in a scientific journal for near and distant readers. There are certain striking differences between the styles appropriate to these two forms of presentation. An oral report ought to be so clear that its meaning can be apprehended during its presentation; hence it must be neither so terse as to be obscure, nor so full of detail as to be confusing. It should be spoken, rather than read from manuscript, because the style of a written presentation is usually so condensed that it is not easily understood when read aloud. A printed report may, on the other hand, either from terseness of style or from abundance of detail, require more than one reading before its full value is learned. A printed report may, if desired, be condensed into a short paragraph of ten or twenty lines, giving only an abstract of results; or it may be expanded to fill many pages. An oral report should not be so short as to seem abrupt, or so long as to be fatiguing. An oral report can not be followed easily, if it contain many local names, or numerous quantitative statements and bibliographic citations; but such details are appropriate enough in a printed report, if the subject treated and the space allowed makes them desirable. The selection of topics and the order of presentation should be very carefully considered in an oral report, because the hearers have no escape from the speaker's plan: they must listen to the first part, first, and to the last part, last; and they must hear the whole of it. In a printed report, selection and order are still important, but for different reasons, inasmuch as the readers may run over printed pages rapidly if they wish to, skipping such details as they do not care to read, and even reading the last page first, if a summary is presented only at the end instead of also at the beginning. The preparation of an oral report demands critical care in the selection and definition of terms and in the phrasing of explanations; so that the right words may be immediately used; for the recall of a spoken word is impossible, and the correction of a wrong word by substituting another for it, is awkward and distracting. The preparation of a

printed report also demands care, but the opportunity for revision is here of longer duration, extending even to the correction of the paged proof. Finally, the diagrams, pictures and maps appropriate for a printed essay may be minutely accurate; but such accuracy is generally unnecessary, if not indeed undesirable, in the illustrations that accompany a spoken report.

In view of these contrasts, it is evidently desirable that an investigator should consider the use that he proposes to make of a report while he is preparing it; just as he must consider the intellectual standing of the audience or of the readers to whom it is addressed. Practice in the preparation of reports of different grades is therefore an important part of the training of any student who wishes, in his maturer years, to do his share in guiding the thought of the part of the world that is interested in the subject which he cultivates. He should have actual experience in the delivery of both short and long oral reports, sometimes in elementary form for the easy edification of young hearers, sometimes in advanced technical form for keen criticism by older hearers; also in the writing of short and long reports of elementary and of advanced style. Conscious effort and repeated opportunity are necessary for safe and rapid progress.

Five Styles of Presentation.—Reports, whether spoken or printed, differ also in the method of presentation that they follow. The more commonly employed methods may be named the narrative, the inductive, the analytic, the systematic and the regional methods, each of which may be advantageously employed in certain cases. The narrative method is suitable in rendering preliminary account of journeys in new fields, rather than final account of elaborate investigations; the inductive method is serviceable in reporting investigations of a relatively simple character, in which abundant facts lead to an undisputed result; the analytical method serves for more elaborate investigations, in which several rival hypotheses have to be tested and a safe explanation discovered and demonstrated; the systematic, when the related results of many studies are to be compared, classed and arranged; and the regional, for the climax of geographical work, when a specified district is to be described. These various methods may of course be modified or combined to suit individual needs, and various other methods may be invented; but we can here give further attention only to the five announced, with particular reference to their use in oral reports. What has been said above as to the contrast between oral and written presentation may suffice for the present to indicate the manner in which a report that is to be printed and read must differ from one that is to be spoken and heard.

The Narrative Method.—The presentation of events, observations and reflections in a chronological order is the essential feature of the narrative method. A diary kept during the progress of an excursion,

an investigation or a journey, forms the natural basis for a presentation of this kind. Such a diary should include the writer's reflections as well as his observations; it should contain due account of such subjective matters as personal adventures, with their difficulties and successes, as well as of more objective matters, such as landscapes, climate, people, books, maps and so on. A judicious selection from a diary of this kind will suffice to give a good impression of the physical and mental path followed by an explorer or investigator, and of the varied experiences encountered along it, as well as of the results attained at its end. Appropriate emphasis should be placed upon items of greater importance, so as to prevent too monotonous a recital. The hearers will be aided in understanding the speaker's work, if a clear statement of the object sought is made at the beginning, and a succinct summary of the results gained is presented at the end.

The narrative method is certainly simpler than any other, as to composition and delivery; it is therefore the one which a student may adopt to advantage, the first time he is to make an oral report in a conference. It is also particularly appropriate when entertainment rather than demonstration is intended; hence it is often employed at large popular meetings of geographical societies. In such cases, colloquial rather than technical terms, and an empirical rather than an explanatory style of description are usually employed; but a technical and explanatory style may be used in narration, without stopping for definitions and demonstrations, if the speaker prefers it and if the hearers may be fairly expected to understand it. Under such conditions a general explanatory summary, presented at the beginning without argument or proof, serves well as an introduction. Space for such a summary can often be gained by omitting apologetic introductory remarks.

The narrative method is appropriate in scientific gatherings when the successive steps of home study or the successive events of a journey are of so exceptional a nature as to be as interesting as the results to which they led. Such, however, will seldom be the case in the work of university students, to whom this supplement is addressed; they will therefore seldom have occasion to employ the narrative method after first practise in it, as above indicated: but it is certainly profitable for every student to make at least one intentional trial in narrative, in order to learn something of its quality and value from his own experience in preparing and presenting it, and from the behavior of his audience in listening to it and commenting upon it. If it costs a speaker some regrets to omit certain items of personal experience, in order to compress his report into the time allotted for it, he may be comforted on realizing that his hearers will not share his regrets, because they will be unaware that anything of interest has been omitted. If, however, his narrative arouses animated questioning at its end, he may

then very effectively introduce items that were before held in reserve. In every case, inasmuch as complete narration is impossible, it is desirable to select for it such items as form a reasonably connected story, dominated by a single line of interest; for in this way the attention of the hearers will be much better held than by a rambling recital of disconnected items. Even in so unambitious a method of presentation as the narrative, it is well to recognize that artistic form and graceful phrasing deserve careful attention. These matters should not be so much neglected as to give ground for the reproach, often directed against the work of scientists, that their style is awkward, involved and obscure, or that their interest in substance causes them to neglect form. It well repays a speaker's care in these subordinate matters, if his audience, often more by their manner than by their words, show that they have had pleasure as well as profit in listening to him. Similarly, such trifles as clear enunciation and easy gestures should be cultivated from the first, just as the ridiculous habit of talking to the blackboard or of . . . eh . . . eh . . . awkwardly pausing . . . eh . . . eh . . . when there is nothing . . . eh . . . eh . . . to pause for, should be avoided

Inductive Presentation.—The chief difference of inductive from narrative presentation is that it does not present facts and experiences in the sequence of time, but in a carefully selected order, so that a gradual progress shall be made from the simplest facts at the beginning, through gradually added complications, to safely established generalizations at the end. Personal adventures and reflections here have relatively small place. The order in which the facts were observed and the generalizations were formed is here no guide; for some of the best examples of characteristic facts may have been latest found; and a very satisfactory generalization may have been reached, at least tentatively, at an early date. Their inductive presentation must in such cases be reversed from the order in which they were recognized.

The peculiar value of the inductive method lies largely in the directness with which the speaker leads his hearers from his observations to his conclusion. It is characteristically a linear method, like narration, but its items are presented in order of evidence, instead of in order of time. The inductive method is therefore most appropriate when one is reporting upon problems of no great complexity, when a full assortment of pertinent facts is accessible, and when the conclusion announced at the end is fully substantiated by the facts that lead to it. If the facts are so scanty that they must be supplemented by theory, if the conclusion appears to remain in doubt, or if no safe decision is made among several alternative generalizations, then the inductive method with its linear procedure, is less satisfactory than the analytical method, next to be considered.

The inductive method is moreover best adapted to audiences which sit in the attitude of docile learners, willing to follow patiently wherever

the speaker may conduct them, and to accept his results without question. It is less satisfactory when the hearers are the equals or the seniors of the speaker, so that they may properly assume a critical attitude, and reasonably desire to form their own estimate as to the validity of the conclusion announced; for in this case they must wish to know, not at the end, but at the outset, the conclusion up to which the speaker leads the inductive procession of facts, in order that they may at once consider the bearing of each fact on the conclusion when the fact is mentioned. It is indeed difficult for hearers to assume a critical attitude during a purely inductive presentation, because it is not the individual facts as they are presented, but the conclusion which is reached at the end, that is to be criticized. Hence if criticism is desired, it is advisable to modify the inductive method at least so far as to announce the conclusion in its most simple form at the beginning, even if it is repeated in fuller form at the end.

It will often happen that a study may cover so wide a field or that a journey may bring to light so varied an assortment of facts, that an inductive presentation of all of them would be distracting, by reason of leading along many diverse lines. It is then advisable, in view of the necessity of compressing the labor of weeks or months into an hour of speaking, as well as in view of the importance of concentrating the attention upon the moderate number of points that an audience can fairly apprehend, to allow no more than light or brief mention to many topics, if indeed most of them are not wholly omitted, and to select for inductive presentation only such part of the whole story as lends itself to orderly arrangement, culminating in as novel and as interesting a climax as possible. Clear marching order of successive items is indeed particularly desirable in inductive presentation. It is furthermore highly important that, while the speaker is marshalling his facts in systematic order, his conclusion should not become so plain that his audience perceives it before he announces it; for nothing is less effective than for a speaker finally to state as a novelty a conclusion which his hearers have reached before him. If there is any danger of so untoward a result, the speaker will do well to introduce his conclusion at some midway point, so as to be sure that his hearers shall not anticipate him in arriving at it.

An advantage sometimes claimed for inductive presentation is that it is safe; but this quality, particularly in somewhat complex problems, is more apparent than real. Presentation truly has everything to do with the clearness with which the results of an investigation may be apprehended, but it has nothing to do with the safety of the results; their safety is altogether dependent on the critical thoroughness with which the investigation that led to them was carried on. Moreover, as was shown in the first part of this discussion, it is never the case that a conclusion, in which the unseen events of the past are largely involved,

can be reached by induction alone. Invention of hypotheses, deduction of consequences, and so on, all have their share in reaching such a conclusion; hence even if an inductive order is adopted in approaching the conclusion, the whole evidence for it can not be set forth in this way. A full demonstration of such a conclusion must necessarily involve some other processes than pure induction. If the presentation appears to be purely inductive, the hearers will have a right to infer that certain important steps have been tacitly passed over; and the speaker may feel sure that if such omissions are detected by any of his hearers, they will form an unfavorable opinion, because of his want of candor or of thoroughness.

The Analytical Method.—This method is characterized by the presentation, at least in outline, of the successive steps that have led the investigator from his original field of observation to the invention of various hypotheses, to the recognition of the most successful hypothesis, and if possible to its establishment as a verified theory, following the plan set forth in the earlier part of this essay. This method is therefore most appropriate in the presentation of complicated problems which demand much theoretical supplement to observation, in the exposition of problems regarding which various unlike opinions have been held by different investigators, and before hearers who are fully able to appreciate rigorous scientific discussion. The essential feature of this method of presentation is that it should preserve the demonstrative quality of the investigation that it represents, and that it should proceed in such an order that the hearers may form a critical opinion as to the value of the conclusion reached at its end. Hence, just as in the usual presentation of a geometrical problem, so in an analytical presentation of a geographical problem, the conclusion or theorem to which the demonstration leads, is advisedly stated not only at the end, but also at the opening of the speaker's address, in order that the hearers may bear it in mind while observed facts, invented hypotheses, deduced consequences, and so on, are all set forth in proper sequence. Only when thus aided by being told the end at the beginning can hearers, who are not familiar with the problem under discussion, really form a competent and critical opinion as to the thoroughness with which it has been investigated.

In view of the short time at a speaker's disposal, the analysis of a complicated investigation can of course be presented only in abstract; but by careful selection of the chief points, it is possible not only to set forth in analytical fashion the leading facts and the most important hypotheses, but also, by impartially confronting the consequences with the facts, to exhibit with convincing clearness the grounds for the final acceptance of one hypothesis and the rejection of its competitors. It should be recognized that while a speaker is thus concerning himself largely with the discussion of past processes, he is for the time being a

geologist rather than a geographer; but he can show his allegiance to his chosen science by making it clear to his hearers as well as to himself that, however much he may delve in the past, his object in doing so is solely in order better to understand the present.

In contrast with the inductive and other methods of presentation, the chief characteristic of the analytical method consists therefore in the candid completeness with which it reveals and discusses the various steps by which the investigator passes from the incomplete conception of his problem, based directly on observable facts, to the complete and comprehensive scheme which he has been led to believe is the true counterpart of the whole enchainment of facts, past and present, involved in his problem. Inductive presentation may lead, as has been shown above, to an understanding of single groups of simple facts, but it can not alone go so far as to reach the fuller meaning of combined groups of complicated facts, many of which are of past occurrence. But for that matter analytical presentation also may stop, on presenting several independent, uncorrelated explanations of separately grouped facts, and thus fail of being as broad and comprehensive as it should be. On the other hand, the desirable goal of analytical investigation and presentation is a well-correlated explanation of all the facts that have come under investigation; that is, a convincingly clear view of so much of their total history as is already past and as bears helpfully on understanding and describing their present condition. It is practically impossible to go so far as this, without adding invention, deduction, comparison, revision and final judgment to the earlier processes of observation and induction.

But there is another advantage possessed by analytical presentation, besides its comprehensiveness. It is well known that a speaker can best commend his work and himself to his hearers by a frank exposition of the reasons that have led him to certain conclusions rather than to others; and there is surely no way in which a clearer and more open exposition of the reasons for belief can be set forth than by presenting, at least in outline, the logical analytical method already described under the account of investigation.

Analytical presentation is moreover particularly to be recommended in preparation for the explanatory as contrasted with the empirical description of land forms; for inasmuch as all explanatory treatment is open to error, it is important not only to take precautions against error during investigation in every possible way, but also to make it plain to one's hearers that these precautions have actually been taken. The speaker should therefore frankly recognize the possibility of error, and then show, by critically analyzing the grounds of belief, that every precaution has been taken to insure its correctness.

During the progress of an analytical presentation, the speaker must take care to show no personal preference for one hypothesis over

another; he must assume the impartial attitude of a just judge rather than the partisan attitude of a retained lawyer. He must not advocate any particular theory, or urge any special conclusion upon his hearers; it is for the facts themselves to advocate the acceptance of whatever hypothesis best accounts for them; it is for the consequences that successfully confront the facts to urge the acceptance of the hypothesis from which they were deduced. The speaker should avoid the use of such words as maintain and admit; for "maintain" implies a prejudiced persistence in an opinion and an unwillingness to revise it in the light of new facts or hypotheses; and "admit" implies the unwilling acceptance of facts or deductions which ought to be accepted willingly and hospitably, if they are at all pertinent to the problem in hand. There is indeed much significance here in the choice of words and phrases. A speaker may fairly urge upon his hearers the consideration but not the acceptance of a certain hypothesis; he may properly insist upon the importance of thorough work, but not upon the belief in his conclusions; he may hold that critical revision of all steps in theoretical work is essential to success, but he ought not to hold his theoretical results as beyond revision, however confident he may be of their correctness. His words show his state of mind in all these respects: hence the importance of selecting them carefully. If a speaker says: "Even the latest researches of other geographers have not driven me from the position which I have maintained from the first," his hearers may be excused if they regard him as not open to the consideration of new evidence.

There should never be, here or elsewhere, an appeal to the "authority" of some other investigator as a means of settling a doubtful question; the appeal should be made only to the evidence that has convinced the other investigator. If there be occasion to dissent from the opinion of other investigators, the dissent should always be expressed courteously: neither in spoken nor in printed reports should a sincere investigator allow himself to descend to disagreeable personalities, or permit himself to indulge in controversial polemics. His expressions regarding all other students of his subject, whether he agrees with them or not, should be such as shall promote personal intercourse when opportunity for it arises; for with whom can an investigator more advantageously associate than with those who pursue studies like his own, particularly if their conclusions differ from the ones that he has reached.

The analytical method of presentation, perhaps more than any other, demands of the speaker an appreciation of the dramatic element that enters, in greater or less degree, in every report made by an investigator to an audience; but the speaker's part should be that of stage manager rather than that of actor. He should stand, as it were, to one side, withdrawing his own personality so as the more effectively to bring forward the facts, hypotheses and other members of his troupe; each

of which must come upon the stage at the proper time, play its part in the most effective manner, and then retire in favor of the next player. Yet while thus bringing forth the objective elements of the problem as clearly as possible, it is still entirely permissible for the speaker occasionally to speak for himself, in short interludes, as it were, and thus to interject some interesting personal story regarding the discovery of important facts; or to tell of the surprise and delight that he felt at the moment when a happy invention sprang unexpectedly into his mind; or to describe the excitement that he experienced when, on returning to the field in order to determine whether previously unnoticed facts really occurred as the deduced consequences of a certain hypothesis had led him to expect they should, he found one item after another at its appointed place and in its predicted form. But all this personal part should be played simply, without "heroics," so that the attention of the hearers shall not be too much withdrawn from the problem under discussion, or from the conclusion which it reaches.

The Systematic Method.—This method is adapted to the presentation of groups of allied facts in a classified order, according to their kind, and independent of where they occur; it is thus contrasted with regional presentation, which treats all the things that occur in a single district or region, whatever their kind. Attention is given in systematic presentation to the likenesses and differences of allied objects, these likenesses and differences being described either in an empirical or in an explanatory manner. If explanatory descriptions are adopted, the explanations on which they are based should have been previously established by induction or by analysis, and here used as already demonstrated and familiar, so that attention shall be now directed to the classification of the things that are explained, and not to the proof of their explanation: thus, however geological the analytical investigations of a student of geography may have been for a time, their truly geographical object is now set forth. Hence systematic presentation is of a grade that follows inductive and analytical presentation and precedes regional.

The kinds of things appropriate for presentation in classified order by the systematic method may be any group of forms, possessing associated similarities or related differences in structure, in process of carving, or in stage of development, and hence in form. They may be large features like plateaus and mountains or small details like river or valley meanders; but in either case they should be arranged according to the accepted principles of scientific classification, and the plan of classification should be explicitly announced. It is here important to recognize that the explanatory treatment of land forms by the aid of deduction enables one to complete the systematic classification of many forms, that would be very imperfectly treated if a purely em-

pirical method were adopted: and it is desirable that this point should be clearly brought forth in a systematic presentation.

The general principle of classification, alluded to above, is that in first subdividing a group of phenomena, advantage should be taken of the different values of some element common to all of them. For example, all land forms are the surface expression of some kind of structure; hence structure may be well taken as the basis of a first subdivision; and its values may run from simple to complex along some appropriate order. All forms, thus classed according to structure, have been more or less affected by the action of some external process; hence each of the former structural divisions may now be again divided according to the kind of process that has acted upon it. But inasmuch as any process working upon any structure requires time for the accomplishment of effect, a third subdivision may be made according to the stage of advance reached by the external process in its work upon the structural mass; and so on, with relief and texture, or any other elements that are to be considered. It may often happen that, after one or more subdivisions have been made in this way, no single element is found which runs with different values through all the last formed groups; then each of these groups may be subdivided according to the different values of an element that it alone possesses.

Each final kind of land forms is usually represented by a typical example, which may be either an actual occurrence or an idealized instance. The more important types should be illustrated by diagrams, and all the type diagrams should be drawn according to a common plan, uniform in style and scale, so as to subordinate irrelevant dissimilarities and emphasize essential likenesses. The aid of deduction must be frequently called upon, in order to fill out a series of forms, for which only a few members are provided by observation.

Technical terms are necessarily employed rather frequently in a systematic presentation. If they are presumably new to the hearers, it is desirable first to give some account of the thing that the term names, with graphic illustration by simple diagram when possible; then the thing being clearly conceived, the technical term may be introduced as a name for it. Thus the hearers will acquire both the thing and the term in their proper relation. If the term is introduced first, the hearers are placed in the dangerous position of trying to attach a concept to a name, instead of being led to the much safer position of attaching a name to a concept.

It was pointed out in the account of narrative presentation, that a student may to advantage exercise himself in that simple method when making his first appearance before an audience. Let it now be added that he ought surely to have had practise in analytic presentation before he undertake systematic, and in systematic before he undertakes regional, for regional presentation, next to be described, is the most

advanced of all methods, and its proper accomplishment demands training in all the simpler ones. Evidently, systematic studies, whether empirical or explanatory, are the essential precursors of well-planned regional studies, for it is by means of systematic studies that a student determines how competent is his treatment and how complete is his equipment; and furthermore it must be in terms already established that the features of any selected region are to be described. Let no one, therefore, undertake regional description until he has decided for himself upon the kind of description and of classification that he proposes to employ in describing the forms of his selected region, or indeed of any other region: and nothing is so helpful in making and justifying such a decision, as the experience of presenting orally a systematic scheme of classification to a sympathetic but critical audience.

The Regional Method.—Regional presentation of geographical problems may be regarded as the climax towards which all other methods advance: for regional description is the goal of geographical effort. The results of a brief excursion in the field or a rapid journey of exploration may be fittingly presented in narrative form, in which the observed facts, along with personal incidents, are told in the order in which they were noted. Results following from the study of problems which involve the selection of related forms from various fields may be presented inductively, if they are relatively simple, and analytically, if they are complex. Many kinds of things, wherever found, may be shown to have orderly relations by systematic presentation, and the classes of things thus established may be filled with graded examples by deduction, thus greatly extending the equipment of the geographer for further work. But after all this, there still remains the description of various land forms in the peculiar associations that they assume in nature, when they are found together in a given region: and the method of presenting such a description may therefore be called regional.

Regional presentation may be treated empirically, if so desired; or partly empirically, partly in terms of accidental, unintentional, traditional explanation; but for serious scientific work no method is so helpful or so accordant with the evolutionary philosophy which in the last half century has come to dominate so many fields of scientific study, as intentional, thoroughgoing, correlated, explanatory treatment. Evidently, no comprehensive treatment of this kind can be applied to best advantage in regional presentation, until the student has had practical experience with the various simpler methods of presentation already considered; hence the importance of orderly practise in various methods of presentation, as here repeatedly advised.

Both the empirical and the explanatory presentation of a regional problem should be attempted, in order to give the student a proper basis for choice between the more antiquated and the more modern

method. In the purely empirical presentation, all such terms as delta and volcano must be excluded, because they have more or less suggestion of origin, instead of being, like hill and plain, limited to the naming of directly observed facts of form. In the method of thoroughgoing, conscious, correlated explanation, it is of course not intended that explanation should be insisted upon where no satisfactory explanation is found, but that search should be made for explanation everywhere, and if it is not found, explicit announcement should be made of failure to find it, and of dissatisfaction with the empirical treatment that is imposed in such cases.

A regional explanation of the explanatory kind should begin with a leading feature, not necessarily the oldest or the youngest; surely not with minor features; and a concise summary of the region should be presented at the outset, so that the hearers may learn the main theme of the report as soon as possible. For example, in the district of the middle Rhine or of south-central France, the highlands should be at once briefly presented as an uplifted peneplain of deformed structure, with residual elevations (monadnocks) surviving from the cycle in which the peneplain was worn down, and with new valleys eroded during the new cycle introduced by the uplift. At the same time a map should be used to locate the region under consideration, and a generalized diagram should serve as the graphic equivalent of the spoken summary: both the map and the diagram should so clearly serve their purpose, that a pointer—an instrument that is often overworked by inexperienced speakers—is hardly necessary. After the first brief, explanatory summary, the main facts should be stated again in more amplified form, with fuller explanatory description. Next all details may be at leisure embroidered on the general conception thus developed. If this be done skilfully, the hearers will find no difficulty in giving the proper value to each detail, or in placing it where it belongs. If the regional presentation is then extended to include the organic elements of the landscape, the forests and fields, the villages, roads and industries, may all be easily located in their proper relations to the stage on which the organic drama is played.

It is, as a rule, a mistake to begin a regional account with an inductive enumeration of separate items, which are to be gradually placed in order and given explanatory treatment. Such may have been the order of discovery; but it is not suitable for presentation. Far better is it at once, as above suggested, to plunge into the most comprehensive statement possible, so as to give immediately a generalized view of the leading features of the whole region; but it is here assumed that the audience is as advanced as the speaker, prepared like him for regional discussion by extended inductive and analytical studies, and like him well equipped with an abundance of classified type forms, so that they may easily apprehend the various kinds of forms named by

the speaker in the introductory summary. If there is any doubt in this matter, it is for the speaker skilfully to devise a plan by which difficult or novel matters shall not be too soon or too rapidly presented.

Especial care should be taken regarding the use of local names in regional descriptions. It is of no avail, it is indeed confusing to an audience, if a speaker uses the name of an unknown village as a means of indicating the locality of some natural feature, such as a cliff, or a bay. The speaker may truly, by the frequent mention of the local names of distant places, show a great familiarity with that aspect of his subject, but he will at the same time show little comprehension of the small value which such names have for his hearers. Names that are generally known, such as Apennines, Nile, Titicaca, may of course be used without introduction, as guides to smaller features in their neighborhood; but it would be a mistake to say that near Brisighella the valley of the Lamone is of incised meandering form, for few hearers can be assumed to know where so unimportant a village and so small a river lie. Local features, natural or artificial, should therefore be first introduced in terms of their relation to large natural features; and only when thus properly located should their names be added. Furthermore, if allusion may be here made to a relatively trivial matter, the speaker should not indicate the location of the features that he mentions by pointing to a map and saying "*here*" or "*there*": the pointing stick says that; the speaker should say something more by giving the verbal equivalent of the pointer's indication; for example, "at the western base of the mountain range," or "on the southern shore of the lake." Similarly, such phrases as "on this side" or "in that direction" should be replaced by "on the northeastern side," and "in the same direction as that of the river flow."

May we not imagine a student, already practised in narration and induction, in analysis and classification, and now returned from a journey in classic lands, standing near a map of Italy and a diagram of his district, and saying to his hearers: Conceive a subdued range of deformed limestones in the back country, where several rivers, flowing through transverse valleys, emerge upon a lowland which they cross southwestward towards the sea; and then upon this lowland conceive a series of four large volcanoes to be built up, each some thirty or forty kilometers in diameter, but of moderate height and gentle slope, so that they form a series about 150 kilometers in length from northwest to southeast. After growth by eruption, the summits of all the cones are destroyed by engulfment, which forms calderas holding lakes in three of the cones, but in the fourth (southeasternmost) volcano the caldera is filled again by new eruptions. At the same time, consequent drainage erodes shallow radial furrows, which submaturely dissect the gentle outer slopes of the cones. The rivers from the mountainous back country are now obstructed; they turn along the depression

that lies between the subdued limestone range and the long radial slopes of the volcanoes; perhaps they rise in lakes; but not until they are all confluent is an outlet found across the broad and low saddle between the third and fourth volcanoes; this being the lowest saddle presumably because these two volcanoes stand farthest apart. There the united waters of the rivers from the back country cut down a transverse consequent valley roughly a hundred meters in depth, open it to mature width, and prograde a simple cuspate delta in the sea beyond. At the sides of the main valley, the spurs between the radial consequent streams of the neighboring volcanoes are cut off by the river, and frayed out by insequent wet-weather streams into small hills of similar form and subequal height, consisting of tuff lying on the clays of the prevolcanic lowland (or sea bottom), and here, with the subdued Sabine range of the Apennines in the background (northeast) and the blue waters of the Tyrrhene sea in the foreground, on a few of these frayed out hills, not signalized otherwise from their fellows, the Eternal City was built; these hills are the Seven Hills of Rome.

Three or four minutes may be required for this introductory statement. The various specifications introduced in these few minutes—subdued mountains of deformed limestones; large volcanic cones, with calderas of engulfment replacing their original summits, and radial consequent valleys submaturely dissecting their gentle outward slopes; a consequent river, traversing the sag of a broad saddle between two neighboring volcanic slopes, eroding a mature consequent valley, and prograding a simple cuspate delta—all these specifications are easily understood by hearers who are ready to listen to explanatory regional descriptions. The relative positions of the several features may be indicated by a blackboard diagram, or by a lantern slide made from a pen and ink drawing, and are all so easily conceived that it is not really necessary to point even once to the diagram as the successive elements of the landscape are mentioned. At the end of the three minutes the hearers will have grasped the essential features of the district about Rome. Then a second and fuller statement of the same facts may be begun, from which the hearers may learn that the limestones of the Sabine mountains seem to be of subequable resistance, for the bare domes of the subdued range have rounded forms of coarse texture, without distinct exhibition of structural trends in the ridges or valleys; that there are many small irregularities in the course of the consequent valleys of the volcanic slopes, previously described as of radial arrangement, a geometrical phrase that suffices very well as a first approximation to the fact, but which thus suffices only because it serves as a good beginning for a closer approximation; that the longitudinal river in the depression between the limestone range and the volcanoes receives three branches from the back country, the northernmost and largest bearing the Tiber name to its head in the valleys of the central Apennines,

the other two named the Nera and the Teverone; that the Tiber delta has been prograded about fifteen kilometers from the original river mouth at the outer side of the volcanic saddle; and so on. Thus at the end of eight or ten minutes, the hearers will be well prepared for any details that may follow; details, for example concerning various smaller calderas in the truncated volcanic cones; or concerning the meanders of the Tiber; or concerning the origin of the cascades at Tivoli by travertine aggradation at the mouth of a formerly normal and mature valley in the limestone range east of Rome. Each detail will fall easily into place, and take proper rank among its fellows.

When it is remembered that, however accurately the features of a region may be known to the geographer who has studied them on the ground, they can—apart from maps—become known to those who have not been on the ground only through such report as the observer may give concerning them, it will be recognized that the attention here directed to the art of presentation as a supplement to the science of investigation is fully deserved.

Printed Reports.—If allowance is made for the necessary contrasts between oral and printed presentation, as summarized at the beginning of this supplement, the suggestions given above as to the different styles of presentation for reports on geographical problems may apply to printed essays in scientific journals, as well as to spoken communications made at scientific meetings: but there are certain additional features of printed reports, especially if they are long and detailed, which deserve consideration. In preparing such reports, it must be borne in mind that an enormous amount of printed matter is issued in these modern times; and that even within the limits of a single science there is much more material published than can possibly be read by any one man. Hence if the author of an essay desires to increase his chance of gaining the attention of his colleagues, he ought to give particular attention to making his text easily intelligible. Several recommendable means of realizing this object may be briefly stated.

In long and detailed essays, it is extremely helpful to the reader to find a summary of contents presented in an introductory paragraph. The value of such a summary here is much the same as at the beginning of an oral report: it enables the reader, when he comes to the later pages, to perceive the bearing of each part on the whole. A summary at the end of an essay by no means takes the place of one at the beginning; for the author who places a summary only at the end of his report evidently regards that as the proper place for its reading; and hence prepares it in a style which may be easily understood at the end of the article, but which is necessarily quite unlike the style of an opening summary that is to be read as an introduction to everything that follows. Two summaries, one at the beginning in proper introductory phraseology, and one at the end in much more specialized phraseology,

are valuable additions to every valuable article. But an introductory summary has still another value: it enables a reader quickly to determine whether he ought to read the rest of the essay or not, and this, in an era of over-abundant publication, is a service that will secure to the author the gratitude of many strangers to the rest of his work. Still another aid to the reader is afforded by a brief statement of the plan of treatment, may well follow the introductory summary of results; the reader can then, if he wishes, give attention only to some particular part of the essay which interests him, and pass over the rest.

Page headings and sectional headings deserve careful preparation because of their great value to the reader. Page headings are, however, often determined more by the editor of a journal or publisher of a book than by the author. But if authors more frequently protested against the undesirable form of page headings often in use, improvement in this respect might be sooner attained. It is surely of no practical value to a reader, who consults, for example, a volume of the "National Journal of Physiography," to find that name repeated at the head of every left-hand page. The name of a journal is sufficiently given on the title page and on the cover of the volume. Likewise it is not particularly helpful to read in every left-page heading of a long essay, "J. Smith," and in every right-page heading, "The Geography of Uruguay." In such an essay, the left heading should give the author's name and a short catch-title, as "Smith: Uruguay"; and the right heading should state the chief topics of the two pages that lie open with it, as "Coast and Harbors." It is always the convenience of the reader, not the preference of an editor, or the fashion of a printer, or the habit of a librarian that should determine matters of this sort. Old-fashioned habit is, however, sometimes so powerful that the reader's convenience is less thought of than consistency with a scheme of page headings adopted many years ago.

Sectional headings are usually within the control of the author. Let him then see that this authority is used for the benefit of his readers. There should be at least one sectional heading for every two or three pages; indeed a more frequent use of sectional headings is ordinarily possible and convenient. If all such headings and their page numbers are gathered in a table of contents at the beginning of a long essay, so much the better for the reader.

Good technical style is frequently neglected in making references to other authors. The titles of cited books and articles are best placed all together at the end of an article, or at the end of the chapters of a book; they should always be scrupulously accurate and complete. Citations in foot-notes, and especially such abbreviated forms as "loc. cit.," "op. cit.," "ut supra," should be avoided: indeed, foot-notes of all sorts are distracting to the reader. If they relate to the matter of the text, they can usually, by a slight change in phraseology or in arrangement,

be given a better place in the body of the page. Reference to a cited author is conveniently made by small numbers inserted in the text, not in parenthesis. The citations at the end of each chapter then include, opposite the proper reference number, the author's name and initials, the full title of his book or article, and the place and date of publication if a separate book is cited; or the abbreviated title of a periodical, followed by the volume, year and first and last pages. Another approved method of citation places the year of publication and the cited page in parentheses in the text after an author's name, as " Smith ('08, 372)"—or the author's name may also be in the parenthesis, if it is not desired in the text. Then at the end of the essay or chapter, all authors are listed in alphabetical order. The advantage of this method is, that if repeated references are made to an article by the same author, the proper page for each reference is indicated in the text; and the citation is given but once, and then completely and correctly, in the alphabetical list. Reference to an author without complete citation is awkward and unsatisfying. While considering matters of technique, protest must be entered against the utterly reprehensible method of repaging reprints. The original paging should always be retained; the pages should not even be reset, in case an article begins on a left-hand page or in the lower part of a page. Reprints should furthermore always give full statement of the periodical from which they are taken, and of the volume and year of original publication. Neglect of these rules is too frequently the cause either of incorrect citations, or of a large amount of unnecessary trouble when an author has to go to the original volume in a library instead of making reference from a reprint on his own shelves.

More important, however, than these subordinate matters of technique, is the proper illustration of an article. Maps, diagrams and pictures should be used more frequently in geographical articles than is now commonly the case, particularly as in these modern days a process-cut from a pen drawing is about as cheap as the same space of text. The excuse offered by an author for the absence of appropriate drawings is too often that he cannot draw. This may suffice for authors whose education was gained at an earlier time, when geographical instruction was less developed than it is now; but for the future, such an excuse must be taken as indicating poor training. On the other hand, reproductions of poor or uninstructive photographs are becoming nowadays rather too common. A good photograph of a characteristic scene from a well-selected point of view, is admirable, but the space given to a poor photograph can often be occupied to advantage by a generalized diagram. Narrative reports should be accompanied by an easily legible route-map, and by views—either photographs or sketches—of the more significant features encountered on the narrated journey. Inductive essays should be illustrated by appropriate figures of the most significant features upon which its generalizations are based; and also by

schematic diagrams in which the essential elements of a generalized conclusion are summarized. Analytical and systematic essays should include diagrams of ideal forms, as well as pictures of corresponding actual forms. Grouped block diagrams showing successive stages of development are serviceable, because they so compactly present the normal succession of a series of complicated forms, and thereby so greatly aid the understanding of the text. It may, indeed, be fairly claimed for such diagrams that, by permitting the abbreviation of explanations, they save at least as much space as they occupy. It should be added, however, that there is good reason for thinking that the full value of graphic illustrations has not yet been reached; and that active invention as well as better training will surely lead to notable advances. Regional essays should be illustrated by maps and pictures, and especially by simplified and generalized diagrams, in which the distribution of the larger features may be so clearly shown. Outline map-diagrams and profiles are so much less serviceable than block diagrams, that the latter are to be preferred whenever it is possible to prepare them.

The guiding principle here, as in the preceding suggestions, is that everything possible should be done to make the author's meaning easily and clearly intelligible to the reader.

THE WORK OF THE "ALBATROSS" IN THE PHILIPPINES

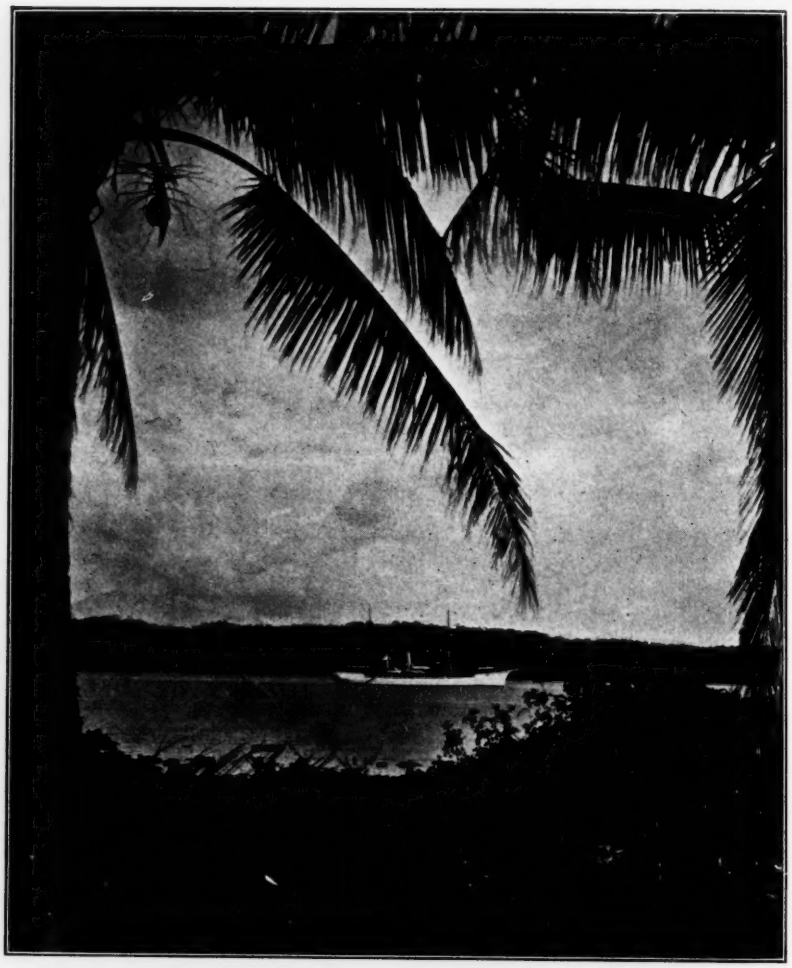
By ALBERT L. BARROWS
NORDHOFF, CAL.

THE *Albatross* is an iron, twin-screw steamer of a thousand tons displacement, built for the United States Commission of Fish and Fisheries in 1883 to enlarge upon the work of fishery investigation and deep-sea exploration begun on a small scale by the *Fishhawk,* a wooden steamer of some two hundred tons burden. Since the spring of 1888, the *Albatross* has been in Pacific waters, where she has made trips to Hawaii and Japan and through several groups of the Polynesian Islands, in addition to many seasons spent among the salmon fisheries of Alaska. For the past two years and a half this ship has been in the Philippines, making as complete a collection as possible of Philippine fish. The normal complement of the *Albatross* is about seventy-five officers and men, detailed from the United States Navy, but during her stay in the Philippines a large portion of the crew was temporarily replaced by Filipino recruits; the uniform of the American sailor is highly attractive to many a Filipino youth. The collecting operations on this cruise have been in charge of a resident naturalist with two assistants, beside two Filipino helpers in the laboratory routine and seamen detailed to the fishing boats. The National Museum has also placed representatives on board, and two Japanese artists have been employed for a part of the trip. In addition to the work of the ship, a special agent of the Bureau of Fisheries has been detailed on shore to compile data on the present supply of fishery products and the demand for them in the Philippines.

The work-room, through which all the specimens are passed, is situated amidships on the main deck. Drawing tables for the artists are hinged to the walls under the ports, and the ship's scientific library is contained in cases along the fore and after bulkheads. A small aquarium of slate and glass is fastened above the sink, and at the side of this there is a battery of four hatching jars. On the deck below this main laboratory is the storeroom, from which open the photographic dark-room and the sick-bay. The smaller specimens, after being sorted, labeled and packed into jars and bottles, are stowed away in lockers here and the larger fish are kept in copper tanks of alcohol. Most of the supplies and collecting gear are stowed in the laboratory hold below this storeroom.

The oceanic work of the *Albatross* is based upon the soundings taken

with the Lucas sounding machine and sounding cups. The machine itself consists of a compact, triple-cylinder, compensating steam engine which turns a reel on which five or six thousand fathoms of steel wire are wound. Geared to the sheave over which the sounding wire runs is a register, which indicates the number of fathoms of wire reeled out.



THE "ALBATROSS" IN PORT. (Photograph by DeLong.)

For depths up to a thousand fathoms, a thirty-five pound shot is used to carry the wire down, and for greater depths a shot of sixty pounds. The shot are perforated with a two-inch hole so that they may be slipped over the cylindrical brass sounding cup. This trips automatically on striking the bottom, dropping the shot, while the sounding cup itself sinks into the mud and brings up an ounce or two as a sample, with the shells and hard remains of countless tiny animals which have played so great a part in the formation of many of the present land masses of the

earth. The four or five thousand separate soundings, made by the *Albatross* during the past twenty-seven years, indicate a long and persistent bombardment of the ocean depths.

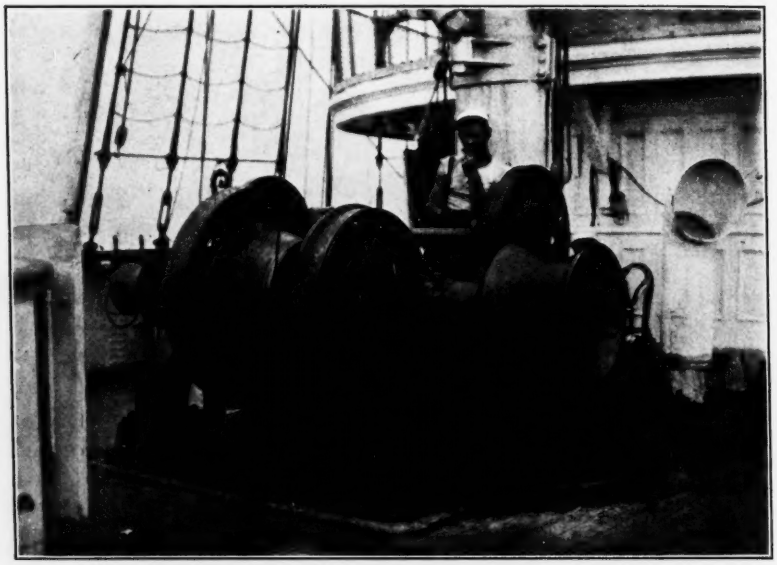
Clamped to the sounding line, a few feet above the bottom specimen cup, is a second brass cylinder used to bring up a sample of the water from the bottom to be tested for its specific gravity. The water bottle is sent down with its valves open, but on being hauled up, the reversed motion of the water against the blades of a propeller-like wheel tightly screws up the valves, and a pint or so of water from the very bottom is brought up through a depth of several hundreds or even thousands of fathoms.

A thermometer in a brass case is also clamped to the sounding line above the water bottle. This is sent down right end up, but on starting back to the surface, a water wheel, similar to that used to close the valves of the water bottle, unscrews a catch holding one end of the thermometer, while the other end is fastened by a loose pin, thus upsetting the instrument, which is now brought to the surface with the mercury in the same position as when it left the bottom. At the same time that the sounding is being made, a specimen of the water at the surface is taken, which is also tested for its temperature and density for comparison with the density of the bottom specimen.

For depths under a hundred fathoms, a hand sounding machine with a light cotton line is used, to which the usual instruments may be attached, unless the navigator wishes merely to determine his position with respect to some shoal. In this case a long weight with a hollow in its end filled with tallow is used, and enough sand or mud sticks to the tallow to indicate the character of the bottom.

On account of cross currents below the surface and on account of the drifting of the ship with the surface currents or the wind, taking a sounding is often extremely difficult, especially if at any great depth, when it requires that the ship be held in one position for several hours. Not infrequently, in spite of the greatest care, the sounding line goes down obliquely instead of perpendicularly and comes across the edge of the rudder or a propeller blade, or a kink is thrown into the line, which causes the wire to snap off at once, and the whole set of instruments is lost. The deepest sounding made from the *Albatross,* while on her Philippine cruise, was in the Sulu Sea at a depth of over 2,200 fathoms. Several successful dredge hauls have been made at depths of over a thousand fathoms, but most of the work has been done in water less than five hundred fathoms deep among the depressions and along the edges of the partially submerged plateau which forms the Philippine archipelago.

The dredging apparatus carried by the *Albatross* is of two sorts, the dredges which are dragged over the bottom and the intermediate nets which are trawled between the surface and the bottom. Of the



THE DREDGING WINCH ON THE FORWARD DECK OF THE "ALBATROSS."
(Photograph by DeLong.)

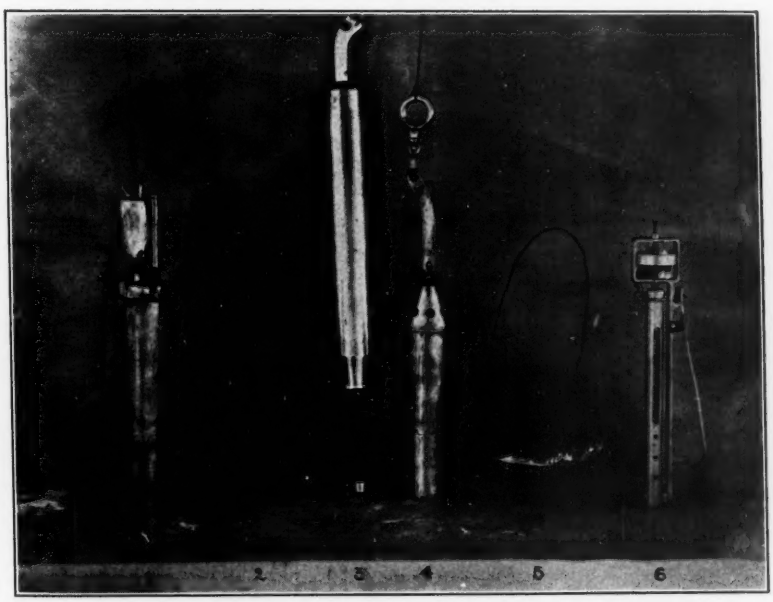
several models of dredges, those designed by Captain Z. L. Tanner, the first captain of the *Albatross,* and by Professor Alexander Agassiz, have been used most frequently. These consist of a pair of heavy iron running frames at the sides of the mouth of the dredge, connected with one cross bar ten or twelve feet long in the Tanner model, and by two such bars in the Agassiz type. Lashed to this frame is a cone-shaped bag, twenty or thirty feet long, made of heavy webbing, with much finer meshes near the tail than near the mouth, and with a lining of fine webbing in the after part of the bag, the end being closed by a lashing. An extra-heavy, six-foot dredge, fitted with strong teeth on the lower beam, was also built for raking over the pearl oyster beds in the southern part of the archipelago, and this small dredge has also been used to good advantage in collecting over other unusually rough bottoms.

During the Philippine cruise, the largest beam-trawl ever used by the *Albatross* was made by connecting the usual iron runners with twenty-five-foot spars, and lashing to these a bag over sixty feet long. This net was handled with great success on a smooth ocean floor until, while dredging in Batangas Bay on Washington's Birthday, 1909, the dredge caught on some obstruction and, after a moment of severe tension, gave way. When the wreck was brought to the surface, it was found that both of the heavy pine spars had been snapped in two, and that only a few shreds of the long bag were left hanging to the remains of the frame. This, indeed, is the fate of many a good, deep-sea dredge.

Two models of nets have been used for trawling between the surface

and the bottom. One consisted of a heavily weighted ten-foot iron ring to which was lashed a lined bag of fine mesh. This net was wrecked in a typhoon encountered off the coast of northern Luzon, as it stood lashed to the fore rigging, and was replaced by a net of Norwegian model. The bag of the latter was made with a shear board at each corner of its triangular mouth, set so as to draw the net down as it was towed, and at the same time to hold the mouth open for thirty feet on a side.

These dredges and tow nets are put over the starboard side of the ship by a heavy boom swung from the foremast. The steel dredging cable, five or six thousand fathoms of which are wound on a huge drum on the berth-deck below, passes over a sheave at the heel of this boom so geared as to indicate upon a dial the number of fathoms of cable paid out. To relieve the severe tension on the dredging cable, which often amounts to four or five tons, two sets of rubber buffers are inserted in the rigging of the boom. One of these, fastened perpendicularly to the foremast, moves a pointer over a scale, indicating roughly in tons the strain upon the cable. Fisherman's luck prevails on the *Albatross,* as elsewhere, and often the dredge is brought to the surface with a great hole torn in the side; or occasionally the whole bag gives way under a big load as the dredge is being lifted aboard, and the collector sees all his expected treasures float rapidly astern or disappear into the dark blue water beneath the ship.



A SET OF SOUNDING INSTRUMENTS. 1, water bottle; 2, thirty-five-pound shot; 3, Thompson bail-cutting sounding rod; 4, bottom specimen cup; 5, sixty-pound shot; 6, deep-sea thermometer. (Photograph by DeLong)

Professor C. A. Kofoid, of the University of California, has designed a small, surface tow net, made of fine bolting silk, to collect the swarms of minute animals—salpæ, medusæ, arthropoda and the metamorphic forms of other groups—which are always found at the surface of the open sea or a few feet below it. While making a bottom haul, this small net is usually towed from the ship's side for half an hour, and the contents are washed out into a jar as a gelatinous, unrecognizable mass to be sorted over in the laboratory at Washington later.

Much of the collecting work of the *Albatross* has been done along clear beaches and in rivers with seines drawn by a crew of six or eight men. The boat used on these expeditions is a round-bottomed, keelless shell of Norwegian model, called a "praam," a craft which is easily held against currents, but which drifts readily with the wind, and which shows on the whole a more unmanageable disposition than any other of the ship's small boats, until one has learned how to trim the boat and to pull it with even oar. Then one realizes how well suited this boat is for knocking about in swamps and rivers and on the beaches.

But more sweeping than any of these other methods of collecting is dynamiting the fish which congregate in great numbers on the coral reefs. Peering through a water glass, or glass-bottomed bucket, over the stern of a small boat, one plants a shot which is exploded by an electric fuse. The fish are either stunned or killed by the explosion and rise to the surface, dotting it with flecks of red, green, yellow, or chocolate brown. Many more fish sink to the bottom, the degree of the congestion of the internal organs due to the explosion and the bursting of the swim-bladder apparently causing the fish to sink. Amid more or less excitement the fish on the surface are speedily gathered in and the boat devotes itself to the more prosaic work of picking up the fish on the bottom with the aid of the water glass and an unweildy bamboo spear. Although one can not but regret the waste of many fish killed by dynamite for every specimen sent to the museum, this method is justified because it is the only means by which many species can possibly be taken, which must otherwise remain unknown.

There is, however, one small wrasse fish (*Labroides paradiseus* Bleeker) about as long as one's finger, which fearlessly flaunts its dark blue tail among the coral branches as the dynamite shot is being placed, and which even more saucily hovers near the jagged and broken coral after the shot has been fired. One's pride in his catch is humbled still further on meeting a silent, half-naked native poling his flimsy bamboo raft homeward with his basket filled with fish similar to those in the dynamite boat. The native has taken his fish in the early morning, before the breeze has ruffled the surface of the bay, without the help of dynamite or of water glass, and with only a slender, iron-tipped spear of his own rude contriving with which he has speared his fish alive.

The dynamiting work is, perhaps, the most fascinating of the collecting activities of the *Albatross*. Through the small, square, pane of the water glass, one sees the rough and jagged ledge of coral, gray or brown in the background, with encrusting forms of blue, purple, sea-green, brown, orange and varying shades of red and pink. The ledge is shattered and honeycombed into an intricate maze of crevices and pinnacles—a broken and rugged floor mottled with irregular patches of color. Huge masses of fluffy, gray soft-coral are mingled with beds of crinoids moving their long, chrysanthemum-like arms to and fro with the ground motion of the swell. Points of rock protrude among these uneven garden plots or are partially hidden by the waving masses of hydroids. Here, a delicate sea-fan stands erect upon a rocky corner; a spotted crab runs from one hiding place to another; and a great, blue starfish sprawls over a bare rock. There, a sea-cucumber, like a stout serpent, halts in the middle of a patch of sand; and among the rocks rest the giant clams with their wide open velvety mouths. A cluster of little anemones gaze upward in astonishment, and a sea-urchin huddles into a crack, like a porcupine searching for grubs among logs.

The coral usually grows out from the shore as a fringing reef, often forming a table or a coral shelf with only a few feet of water above it, and ending abruptly in a coral cliff. There are found the most luxuriant growths, as the bottom rapidly recedes from a depth of one or two fathoms to a depth of ten or fifteen fathoms, beyond which the eye, aided even with the water glass and the brightest sunlight, can not penetrate. These are the reefs of solid coral formation.

Around other islands, the coral is merely an incrustation on the rocky ledges which form the island. Occasionally a locality is found like that of the volcanic island of Kagayan Sulu, where the coral which once flourished has been killed, possibly by some change in the ocean currents or by a volcanic uplift of the island. The finer structures have been worn away and the bases of the clumps of coral stone are now covered with the slime of a fine, brown alga.

The next reef visited may be farther up the bay and bear a character very different from that of the reefs on the exposed points. Huge, goblet-shaped sponges of a living gray color stand up motionless on their thick stalks between great tables of spiny coral borne on pedestals, each little spine on these tables looking like one of the trees on a wide, pine-forested plateau. Beautiful brown plate corals and shelf corals hang along the walls of the ledges.

Another type of coral, growing sparsely over a sandy bed, may be the last representative of the coral animal to be found well inside the bay. The growth consists of hedges and patches of the diffuse and intricate tangle of branching, stag-horn corals. Scattered among the brown sea-grasses between these hedges which parallel the shore are

solid head corals, large and small, fluted and knobbed, and often with their somber colors of brown and gray suggesting the head of some ancient monk half buried in the sands, while the coral branches still bear upon their tips the brilliant purple of the priest's altar robes.

It is a quiet scene. There is no glare. The colors are clear and living. It is a garden of animals, but few of which are capable of motion, though the currents and waves carry some of the slender forms to and fro in a semblance of voluntary activity. Other forms rigidly keep their one position. Never a sound is heard from these depths. Never comes a perfume or an odor from this garden. If we pluck one of these flowers from its home, it collapses and fades. We are allowed a glimpse of this new world, but never an approach into it, and we are left to marvel at Nature's lavish extravagance in creating life.

The active denizens of this luxuriant garden are the fish that dart from clump to clump of coral, or prowl among the broken rocks, or hover in swarms about some, single coral head, or listlessly rest in the hollows of the bottom. The bright colors of tropical fish are well known. Red, blue, green and yellow are painted on them in intricate and bizarre patterns. More striking even than their surroundings, most of these fish apparently do not seek protection by inconspicuous coloration. The reef fish form a class by themselves. Once in a while, a gray shark helps himself to the spoils after the disturbance of the dynamite shot has been forgotten; a sea-turtle flaps his way under the boat and, rising to the surface fifty yards away, thrusts his crooked head and neck out of the water for a more careful scrutiny of the intruder; and an eel searches through the holes in the coral or gracefully waves his ribbon-like form over the ledge into the next submarine gorge.

The patient drawing of the seine along the beaches yields an entirely different group of fish, most of them slender, swift swimmers and light or silvery in color. In the tide pools left among the rocks, are found grotesque little scorpion fishes and blennies and gobies. The seining party usually divides its time between the beach and a small river the tidal portion of which winds its tortuous way through a monotonous mangrove swamp. As the boat is pulled between the glistening, green hedges of mangrove trees which line the sluggish, muddy water-way, even the hum of gnats and mosquitoes, the harsh cry of a bird, the snapping of the oysters and clams in the mud left uncovered by the receding tide, and the occasional splash of a big lizard dropping into the water, add to the solitude of the dismal waste. In the southern party of the archipelago almost every bay and inlet is partly filled with mangroves and they often form a fringe three of four miles wide along the shore.

The results from dredging cover almost the full range of the marine animal kingdom. There is usually a great quantity of mud in the net, much of which can be washed out by towing the net at the surface of

the sea for a few minutes. After the net is swung aboard, the load is dropped on the gratings of the washing table by taking off the lashing around the end of the net, and the hose is turned on to wash the mud away from the specimens. Most of these fish of the deep-sea are small but strange enough in comparison with the surface fish. Many are slate colored; a few partake of reddish brown; and some are inky black with a row of phosphorescent spots along each side which, in the utter darkness of their native depths, must glow like the portholes of a steamer at night. The other specimens in the net may show that the dredge has been drawn through a bed of siliceous sponges, of crinoids, or of Venus's flower baskets, or through a multitude of starfishes and sea-urchins. Still other dredge loads may yield small sea-snails and bivalves, weak and awkward spider crabs and many smaller crabs, the omnipresent shrimp, a few sea-cucumbers, squids, basket-stars, sand-dollars, beautiful sea-fans, hydroids and solitary corals, with jelly fish probably from intermediate depths. In the crevices of pieces of coral and sponge broken off by the dredge, are also found numbers of tiny fish, small crabs and worms. Finally, samples of the sand and shell fragments are dried and taken for specimens.

The routine of the dredging is sometimes broken by fishing for sharks with hook and line from the ship's side. Several blocks and chips of wood, which had been thrown overboard a few hours before, were taken from the stomach of one shark caught in this way, together with scraps from the ship's galley. Once a few small whales were seen spouting among the dazzling ripples of the early morning; and schools of porpoises have often lumbered past the ship, their huge bodies tumbling over and over one another in short, low curves.

In the evening, while the strains of the ship's phonograph and the thrumming of a Filipino mandolin or guitar drift back from the forward deck, the fishing gear is brought out again, if the water at the anchorage is quiet, and often most interesting results are obtained by scooping up with a fine meshed dip-net the hundreds of little creatures which are attracted to a submarine electric light. Not only such fish as herrings, anchovies and half-beaks, with now and then an excited flying-fish, but many squids darting back and forth more swiftly than the fish, small crustaceans, jelly-fishes and phosphorescent worms are taken; and sometimes a water snake writhes across the edge of the outer shadow, or the dark form of a shark glides under the vessel.

The work of the *Albatross* has been thorough along the line which has been her specialty on this cruise. It is seldom that any region can be carefully surveyed by an expedition carrying the equipment of the *Albatross* and detailed for so long a time as this ship has been to the study of the fish and the fishery resources of so rich a collecting ground as the waters of the Philippine Islands. Still, this work has been that

of a collector only, and its economic value will not appear until these results have been used for the greater development of the remarkable fishery resources of these islands than the native fisherman now make of them. These are fishermen who catch fish principally for the supply of the local community; who use for food nearly every kind of fish which is caught, with but little care for possible by-products; and who now preserve the fish, if at all, only by the crudest methods. Aside from the purely scientific additions to knowledge, the results of this Philippine expedition of the *Albatross* contain material which should benefit not only the fishermen as a class and many a Filipino who already uses fish as a staple article of his diet, but also a great number of the population, living inland from the coast, to whom the best species of fish properly cured would be a welcome and a wholesome addition to an often too restricted fare.

THE STORY OF A KING AND QUEEN

By Professor CYRIL G. HOPKINS
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ONCE upon a time a young king started out to find a better country and a better people. He had been born and raised among the common children of his country, but none of them suspected him to be a king. Even he himself scarcely realized his royal birth, and never guessed the golden harvest that one day would be his after he had really discovered his own country and established his rule over it.

So eager was he to find his kingdom and the people he was to rule over that he set out even before he was fully grown, and like all good travelers followed the sun westward, leaving behind the rugged hillsides where as a child he had lived near the great sea.

Westward, ever westward, the young king traveled, and once he thought he had found his land and his people beyond the mountains in the valley of the Great Miami;[1] but he soon learned that he was to rule a larger kingdom in a greater country still nearer the setting sun. And as he wandered on, he came, at last, to the Land of the Illini[2] which stretched away farther than the eye could see, a broad expanse of almost unbroken prairie land.

"This," said he, "is my country, here will I prosper, here will I be happy, and here will I stay and establish my kingdom." The young king found an ideal home for himself on this dark prairie soil, and for many years he lived as a very independent bachelor; but there finally came a time when the supply of food which he had found already prepared in the soil became partially exhausted, and in hunger he said to himself. "It is not good for man to be alone." He then sought a princess named "Clover," and thereafter always rejoiced that she consented to be his queen. Where she prepared the soil, King Corn was again as well fed as ever.

Queen Clover found that the supply of food in the soil had not been completely exhausted during King Corn's life as a bachelor, but only that the supply of some ready prepared foodstuffs was much depleted, and from the remaining total supply of raw materials she was able to prepare much food fit for the king's use, and she was also able to prepare the king's bed in the soil as it had never before been prepared for him.

Years passed, and they were happy and prosperous years; but finally

[1] The Miami Valley in Ohio.

[2] Illini is the Indian name for Illinois, which means the land of men.

both Corn and Clover were forced to remember the ancient saying: "And this, too, shall pass away." King Corn began to complain again that his bed was getting hard and that the food furnished him was not sufficient. Queen Clover replied that she, too, was suffering from hunger, and that her home in the soil which had always been sweet and clean was becoming sour.

Naturally, Queen Clover was much more sensitive to this condition than King Corn, but she had done the best she could with what she had found in the soil and she had also secured for herself one choice kind of food from the air, and even prepared it for the King so far as she could.

But, in spite of all they could do, Queeen Clover's health began to fail; and some years she was entirely helpless, and consequently King Corn suffered greatly. They consulted many doctors. Some said the soil needed more drainage; others said the seed-bed should be better prepared; and still others advised the use of better seed and of more thorough cultivation.

All of these remedies proved helpful, but they afforded only temporary relief. At last Queen Clover said to the king that when she was a child a doctor, whose name was Science, had once visited her family, and that whatever he did was exactly right because his knowledge was true and absolute. He had shown them that all of the members of the Clover family were able to secure nitrogen from the air, and that this was one of the essential foods for plants.

The king and queen were greatly rejoiced to learn that the old doctor was still living, and they at once secured his services.

After a thorough investigation of the conditions, Doctor Science reported that he understood the case and that the remedy was simple and still within easy reach, but that they should proceed at once to apply the treatment before it became too late.

"The fundamental trouble," said he to King Corn, "is with the soil in which you live. In order to establish a permanent and healthful home for yourself and Queen Clover, about one half ton per acre of pure steamed bone meal, or of fine-ground natural rock phosphate, and two tons per acre of ground limestone should be applied once every four or five years. Then don't occupy the land too much of the time yourself, but bring in other crops and have a rotation—such as corn, oats and clover, or corn, wheat and clover for a three-year rotation; or wheat, corn, oats and clover (in grain farming), or corn, corn, oats and clover (in live-stock farming), for a four-year rotation. In the four-year rotation for grain farming a catch crop of clover may also be seeded on the wheat ground and plowed under the next spring for corn, and the regular clover crop in the fourth year may be mowed once or twice and left lying on the land, the seed crop afterward being harvested with a buncher attached to the mower.

1909 CORN, WHERE THE CLOVER AND ALL CROPS ARE REMOVED AND NO TREATMENT APPLIED; yield 35 bushels per acre.

1909 CORN, WHERE CLOVER AND CROP RESIDUES ARE PLOWED UNDER AND LIMESTONE AND PHOSPHORUS APPLIED; yield, 79 bushels per acre.

1909 CORN, WHERE MANURE, LIMESTONE AND PHOSPHORUS ARE APPLIED; yield, 86 bushels per acre.

"In grain farming, only grain or seed should be sold from the farm, all clover, straw and stalks being returned to the land in order to maintain the supply of organic matter and nitrogen, which are just as important as limestone and phosphorus;[3] and in live-stock farming all produce should be used for feed and bedding and all manure carefully saved and returned to the land, preferably within a day or two after it is produced, in order to prevent the waste of plant food."

"Now, do you understand all this?" asked the old Doctor.

"I don't," replied King Corn.

"And I don't," added Queen Clover, "but I have faith in Doctor Science, and I think we should follow his prescription. I know very well that I can't do as much as has been expected of me in the past. I can't make food out of nothing, and the king can't live on just air and water; and the soil is becoming so worn and hard that I can't even make a good bed for him, especially when I'm half starved myself most of the time."

King Corn agreed to this. He had long supposed that Queen Clover could get from the soil and air all of the food they would ever need, but he now remembered how he himself had failed in this as a bachelor, and he felt that Clover had been such a good queen that anything which Doctor Science prescribed should be provided, because above all else he desired to have the queen restored to health and happiness, for he did not care to try to live without her again. On the other hand, they both agreed that they would test the doctor's prescription on part of the land on which they lived and have also some land without such treatment, in order to compare the results.

There were three very uniform fields of typical prairie land which had been in permanent pasture for many years, but on which King Corn had recently lived for three years in succession, and they had produced for him as an average of those years the following yields:

Field A	63 bushels per acre.
Field B	63 bushels per acre.
Field C	66 bushels per acre.

They were now sown for three years to oats, clover and cowpeas, after which each field was divided into three parts and, in accordance with the advice of Doctor Science, limestone and phosphorus were applied, not to all of the fields, however, because a test was to be made of the treatment. Thus no treatment was applied to Field A; limestone alone was applied to Field B, and both limestone and phosphorus to Field C. On all three fields the second crop of clover was plowed under just in proportion to what grew on the land, and in the later years the corn stalks,

[3] Phosphorus is the valuable element of plant food contained in natural rock phosphate and also in bones, and large amounts of phosphorus are required for clover as well as for corn and other crops.

oat straw, and all clover hay and straw were returned to the same fields on which they grew, thus following finally the complete prescription.

A regular three-year rotation was also begun, one third of each field being in corn, one third in oats, and one third in clover, each year; and the next year, corn followed the clover, clover followed the oats, and oats followed the corn.

As an average of the three years, when only partial treatment was used, the yields were as follows:

Field A ..... 67 bushels.
Field B ..... 69 bushels (with limestone applied).
Field C ..... 74 bushels (with limestone and phosphorus).

As an average of these three years, compared with the former record, it was seen that the yield was 4 bushels higher on Field A, 6 bushels higher on Field B, and 8 bushels higher on Field C.

"I think I feel somewhat better," said the King, "and I should like to continue the treatment at least for a few more years."

The oat crop followed corn and thus Queen Clover was compelled to sit at the third table in the rotation, and she had had the full benefit of the limestone and phosphorus for only one year; so she was glad to have a further chance to try the treatment.

As an average of the next six years, the yields per acre of corn were as follows:

Field A ..... 63 bushels.
Field B ..... 67 bushels (with limestone applied).
Field C ..... 87 bushels (with limestone and phosphorus).

At the end of these years the King had his accounts all figured up.

"Field A has gone down again," said he to the Queen. "It has lost the 4 bushels it had gained by the improved rotation."

"Yes," replied the Queen," and I don't like that field a bit. I almost starve when I try to live there, and Field B is growing poor, too."

"So I see," said the King, "by 2 bushels, although limestone has maintained the yield 4 bushels higher than Field A; and where both limestone and phosphorus are used, the average yield is 24 bushels better than without them. That reminds me of old times, my dear. When I was a young bachelor, a yield of 87 bushels per acre was not uncommon."

"You might try 'baching' it again," suggested Clover. "You know I'm not considered of much value, and the oat crop isn't worth very much. Surely, three crops of corn would be worth more than one each of corn, oats and clover."

"No, no," said the king. "I do not care to repeat my experience as a bachelor; and, by the way, I have never confessed to you the real condition I was in when you consented to be my queen. The facts are that

I lived on one field for thirty-one consecutive years, and as an average of the last six years the yield was only 23 bushels per acre. Thus it required three years to produce 69 bushels, whereas 87 bushels are now produced in one year under this system of permanent soil improvement in grain farming; and even 90 bushels per acre are produced where limestone and phosphorus have been used in the live-stock system, which, you remember, was also suggested by Doctor Science, and which we have been trying out on Field D."

The writer also has a confession to make:

The six-year averages of 87 bushels in grain farming and of 90 bushels in live-stock farming are the records of the Illinois Agricultural Experiment Station for the last six years, 1904 to 1909.

1910 CLOVER ON THE FAIRFIELD EXPERIMENT FIELD IN SOUTHERN ILLINOIS. Manure alone (on left) supplies but little phosphorus and will not correct the soil acidity. Manure, limestone and rock phosphate (on right) produces a large yield of clean clover. (If the Corn Belt needs limestone and phosphorus, what shall we say of "Egypt"?)

During the same six years the average yield of oats was as follows:

Field A ..... 48 bushels.
Field B ..... 50 bushels (with limestone applied).
Field C ..... 62 bushels (with limestone and phosphorus).

As an average of three years during which the second crop of clover was harvested for seed, 1907, 1908 and 1909, the yield of clover seed was as follows:

Field A ..... 1.9 bushels.
Field B ..... 2.1 bushels (with limestone applied).
Field C ..... 2.7 bushels (with limestone and phosphorus).

As an average of the last three years, 1907, 1908 and 1909, the yield

of corn on Field A was only 58 bushels, but the limestone and phosphorus together increased the yield of corn by 29 bushels, the yield of oats by 10 bushels, and the yield of clover seed by nearly one bushel per acre. The total value of these three increases is $19.40, counting 40 cents a bushel for corn, 30 cents for oats, and $6.00 a bushel for clover seed. The increase has paid for the cost of the limestone and phosphorus and given in addition a net profit of more than 100 per cent., and besides this the soil of Field C is growing richer and richer, while the soil of Field A and Field B is growing poorer and poorer.

As an average of the three years 1905, 1906 and 1907, the yield of air-dry clover hay in the first cutting was as follows:

Field A ..... .8 ton.
Field B ..... .9 ton (with limestone applied).
Field C ..... 1.8 tons (with limestone and phosphorus).

These clover crops were harvested and removed, thus removing much more phosphorus from Field C than from A or B, but since 1907 all clover except the seed is returned to the land, on all three fields; and hence this story is to be continued.

Nota bene.—Once upon a time a young man came into what is now the heart of the Illinois Corn Belt and found the green grass growing luxuriantly upon the dark prairie soil as far as the eye could see. He had very little money, but the land looked good to him and since it could be obtained from the government at small cost he decided to buy a farm. He began to raise corn and cattle, and even though the price of those products was very low he was soon able to buy more land, and by continuing as he began he became the owner of twenty-seven thousand acres of land before his death. His children and his grandchildren are still living upon the land, which is now worth $200 an acre, even though it requires fertilizing to maintain its productiveness.

While there are eight times as many people in the United States in 1910 as there were when that young man came to McLean County, Illinois, there is now no cheap land anywhere on which corn can be grown with success and profit. Thus the farmer of the present and the farmer of the future must make his success and profit by improving the land now occupied.

THE SOCIAL PROBLEM

By Professor JOHN J. STEVENSON
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MACCHIAVELLI, discussing the choice of political ministers, grouped intellects into three classes: "one which comprehends by itself, another which appreciates what others comprehend, and a third, which neither comprehends by itself nor by the showing of others; the first is the most excellent, the second is good, the third is useless." The last class constitutes the mass in any nation. Draper put Macchiavelli's statement into terse Saxon: "The first group thinks for itself, the second thinks as others think, the third does not think at all." Every man, familiar with "practical politics," knows well that the grouping is as true for this day, and for America, as it was for Italy four centuries ago. In preparing a list of candidates for office, the third class is ignored—it will vote straight. The second class is ignored; it consists of "independents," following slavishly some men in the first group, whose opinions they respect. Those leaders must be considered, but their followers give managers no concern.

The economist is compelled to recognize a similar grouping. His first class consists of men gifted with foresight, able to plan and to execute, able, as it were, to hold the future in the grasp of the present; men of his second class possess these powers in less degree, but lack initiative or mental poise, are apt to be found wanting at critical moments, yet are capable of much as subordinates; while those of the third class are able or willing to work in very narrow paths with little or no responsibility.

In this, as in all classification, the boundaries are indefinite and gradations exist in each group. There are many in the second who, but for some defect, would have been in the first. "He might have been a statesman, if—" or "He ought to have been at the head of great enterprises, but—" are expressions only too familiar. The third class has many who possess almost every qualification for the second, but they are unwilling to undertake serious tasks, preferring to provide for the present as well as for the future by moving along lines of least resistance. Yet the grouping as a generalization is true; it is merely the assertion that differences in men are largely innate, are due only in part to environment. If a man belonging to the first group be born among the lowest of the third, he is certain, in this country, at least, to find his place as leader in politics or in other directions long before

reaching middle age. The division into "classes and masses" is not of man's making; it is part of nature's economy. Men of all groups are born in all grades of society, among the rich as among the poor, and are found among the so-called educated as well as among the illiterate. A man's place depends on his natural endowments.

The vast majority of mankind consider little beyond the present; the inherent indolence can be overcome only by compulsion. The ordinary man finds that compulsion externally in the necessity of providing for immediate needs or against threatened disaster. He may have an indefinite longing for better things, but that incites him to no legitimate effort. The extraordinary man finds compulsion within; he looks far beyond the present, and desire for noteworthy reward impels him to extraordinary exertion. In practically all cases, self-interest is the compelling motive, as much to the man who demands only his daily bread as to the man who seeks an empire. Every advance in civilization, every improvement in the moral or physical condition of mankind in modern times has been due primarily to this self interest. The initiative has come from men of the highest class, who, in executing their plans have utilized men of the other classes and all have shared in the resulting advantage.

"Born leaders" become creators. Men speak of Sir Christopher Wren as the creator of St. Paul's Cathedral because that edifice existed full-formed in his mind before a stone had been quarried for the building. The great intellects, who planned the transcontinental railroads were as truly creators; they saw full-grown a mighty empire beyond the plains, which would come into being as the result of their work but which would be impossible without it. They made not only the railroads but also the empire—they created the values. And the story is the same in the development of every great industrial enterprise.

But without aid from men belonging to the second and third classes creators of values could do little. One may have abundant strength and abundant skill, but without a spade or its equivalent he can not cultivate the ground and he may starve. And just here is the prevalent confusion of ideas. Men fail to recognize the relative importance of director and directed. Some years ago, when the writer expressed admiration for the executive ability of a successful acquaintance he was surprised to learn that the compliments were undeserved. It appeared that the success was due wholly to the "O.P.W. racket," which, being interpreted, means other people's work. This successful man merely concocted business enterprises and assigned to each lieutenant a share in carrying out the plans. Further than that he did little, aside from giving occasional advice, until the time came for division of profits, when he received the largest share. Now, the men selected to look after details had become disgusted, were determined

to be servants no longer and were about to strike against the manipulator who had put them all into comfortable circumstances. The story is the same throughout. The plodding farm-hand can discover no good reason why his employer should occupy a large bed downstairs while he sleeps on a narrower, less ornate couch upstairs; the laborer, who shovels cinders in a mill-yard, knows how necessary his work is to the owner's success; he is convinced that an unfair share of the profits falls to his employer as well as to the man at the rolls. The subordinate everywhere, whatever his position may be, feels that his worth is unrecognized and that his reward is insufficient; while the man outside of all, angry because he has no share whatever, eggs on the discontented, anxious only to see some one injured and hoping that the injury will be distributed in proportion to the reward received.

It is absolutely certain that cooperation of all groups is essential to completion of great projects. Without direction by a master-mind, there could be no utilization of man's labor to the advantage of all. It would be like the superfluous heat of the sun or the force of the coastal tides, each sufficient to perform the whole mechanical work of the world, yet unused and useless because no one has conceived a method of control and application. To all intents and purposes, the energy of the vast mass of mankind is merely so much mechanical force, incapable of self-direction and without utility, unless marshaled by the constructive power of some master-mind.

But without this force the master-mind would be equally helpless. The man who conceived the transcontinental railway was fettered by physical limitations; he could plan the whole undertaking, but, in in order to complete the work within the compass of a single life, he was compelled to make use of other men's powers, mental as well as physical. Among engineers, contractors, operators, the chiefs were men of his own group; but, in each department, there was gradation in responsibility until at the bottom was the indiscriminate mass of employees, handling tools mechanically.

And remuneration, throughout, is graded to accord with the responsibility. The great reward is given to one whose physical output seems to be nothing, who has few hours at the office and many hours, apparently, for relaxation. The reward decreases as hours of physical exertion increase and the minimum is given to the laborer, whose only contribution comes from muscular expenditure. Mind, not muscle, receives the chief reward. Physical labor is a tangible thing, easily comprehended by even a stupid man; whereas proper valuation of mental labor is within the comprehension only of those competent to perform it. The hewer of wood and drawer of water are not to be blamed because they think the rewards of the higher groups disproportionately great; but their discontent is not against anything of human

origin; the disproportion is due to inexorable natural law, for men are born unequal, mentally, morally and physically.

And thus it is that supply and demand determine the matter. The man in position of greatest responsibility, the *vis a tergo,* naturally receives the apparently disproportionate reward, because his group is so small that to replace him is difficult; he deserves the greater part of the gain, be it money or glory, because he alone makes the gain possible. He alone can determine the gradations of responsibility among his subordinates and he assigns rewards according to the relative importance of the services and the difficulty of replacing. The pay of the mere laborer is small because it is worth no more; the supply is in excess of the demand. If at any time demand be in excess of supply, inventive genius enters at once and makes fewer laborers needed, while the work is done better, more cheaply and more expeditiously. During the Civil War, agricultural laborers could not be obtained, but the land did not remain untilled. Gang ploughs, mowing, reaping and threshing machines did the work. When vast enterprises in railway and other construction were undertaken, there was insufficient supply of brainless muscle, living picks, shovels and hods, but the steam shovel, automatic cars, hod elevators and other contrivances quickly made the supply again more than equal to the demand. Experience shows that machinery is preferable to ordinary labor; it can be depended on; its strikes are brief and are overcome quickly.

Skilled mechanics recognize the conditions. Products of even the highest type of hand labor are rarely equal to those of machinery. The hand-made watch is not so good as the watch made by machine at very much less cost. Fifty years ago the man with a trade was a capitalist; but every decade has brought about a decrease in his importance. Machinery has reduced the carpenter to a mere fitter and nail driver; the cabinet maker is little more than a handler of the glue pot and screw driver. It is the same wherever one looks; the outcome is inevitable; mere manual labor will be replaced by machinery in such measure as to render even the better members of the third class barely essential. If this is to be the outcome, what about the great mass of men able or willing to work only as mere pawns in the hands of others?

This question can not be answered in *a priori* fashion. The elements of the problem are not hypothetical, they are cold facts and their interlocking makes the whole complex almost beyond comprehension. It is certain that at present no one student will see more than a little way toward the solution.

The problem is but one part of the greater problem, the elimination of poverty. It is true that incompetents are born in all stations, but it is especially true that poverty leads to their multiplication, while it is also true that their multiplication intensifies the curse of poverty

by increasing the number of those for whom the world has decreasing need. Here the problem concerns only the United States, where the young are fleeing from the farm and are flocking to the cities, already overstocked with unskilled labor of every sort. Actually, the problem concerns the cities alone; it is practically unknown elsewhere.

Those who urge that immigration should be restricted or even prohibited are told that not all immigrants are undesirable—and that is true. Pioneer immigrants from any land are apt to be the best of their race. Those who came from northwestern Europe were, mostly, uneducated and without property; but they dared leave the home of their ancestors and braved the dangers of an unknown land; they thought for themselves and worked with high aims; they made their way and they made the United States. But a very great proportion of immigrants arriving during later years have come because others have proved that the experiment is more than safe. And in too many cases they bring with them erroneous ideals of personal liberty and false conceptions respecting relations of the government to the citizen.

It has been said that this country has need of every able-bodied immigrant who is willing to work; but this a sad misconception of the conditions. Even were the incomers agriculturists there would be room for but a small number, unless all our methods were revolutionized—a process requiring a long period. The available cheap land has been taken up—were there land remaining it would be unavailable, as few of the incomers have enough money to purchase equipment for even a small farm. The assertion that agricultural laborers are in constant demand is an error; for that demand exists only during the brief period of harvest and it is decreasing each year with increasing use of machinery. The acreage of crops is greater than ever, the crops themselves are of greater magnitude than ever before; yet the agricultural population shows steady diminution because fewer workers are needed. One must recognize that there is a limit to any country's capacity to furnish work and that the limit has been reached in this land. For years, the United States could utilize half a million newcomers each year, but its ability in that direction ceased before 1906. During the remarkable building "boom" of 1905, there was not work enough in New York city for the resident bricklayers and masons. In spite of shrewd management by trades unions, there were many skilled workmen who wandered through the streets, seeking work and finding none. Even then, in the midst of superabounding prosperity, was heard the demagogue's cry that work should be supplied by the government, that the scandal might be removed. But the influx still continues; nearly 1,000,000 immigrants arrived during the first half of 1910.

There are great dangers in unrestricted immigration. If it con-

tinue, conditions here must approximate those in the crowded areas of Europe. With increasing surplus of work-seekers, wages must decrease. Severe restriction of immigration should come and come quickly. It is not the duty of those already here to impoverish themselves in an effort to support the distressed or dissatisfied of all lands. Even the golden rule does not require that a man love his neighbor better than himself; and the Apostle Paul, that champion of generosity and self-denial, asserts that whoso careth not for his own is worse than an infidel, he has denied the faith. But restriction of immigration is not enough; the surplus population is already here; our cities are overcrowded with utterly unskilled labor— it is estimated that in New York city alone there are 100,000 unemployed clerks; the great problem is already with us.

Some maintain that the problem is purely ethical; they assert that the law of supply and demand should not be considered in connection with employment; that if employers would consider properly the interests of their employees all difficulties would soon be of the past. But this is purely academic. No doubt conditions would be improved greatly in some respects if the golden rule were the standard of conduct; but it must be remembered that selfishness is not confined to employers and that the sermon should not be preached to them alone. When man's nature has been so changed that each will endeavor to do his full duty, the time will have come for essays on ethics. But as long as the employer seeks to get as much and the employee seeks to give as little as possible for the wages, discussion of the ethical side will remain academic. In any event, it is irrelevant now; it concerns only those for whom there is work; it offers no relief to the increasing number of those for whom no work exists.

The socialist has his remedies. He tells us that all men should have equality of opportunity; that no man should control another's opportunity; that every worker should receive such wages as would enable him to live in comfort according to the American standard.

The implication that opportunities are not equal in this land is so contrary to fact that one can not believe that it is made in good faith. Hardly a quarter of a century has passed since the impoverished Russian immigrants first set foot on our shore, yet they already own much of the lower east side in Manhattan and great tracts in other boroughs. It is conceded that the conditions for some kinds of unskilled labor are terribly bad; one dollar a dozen for making shirts, sixty cents a dozen for making bedspreads, tell the story of misery; but not of slavery. Such sad conditions tell only of competition for work, that awful temptation to the selfishness of employers and of purchasers; they tell only that there are too many workers and too little work; but they do not lead to the suggestion that there should be no employers. And

one must ask what would be the advantage if wages were raised to the "American" standard while work would be provided for only a part of those seeking it. Increased wages of those at work would only increase the misery of those without it, by increasing the cost of living. To be satisfied respecting the relation of wages to cost, one need only compare the prices and wages of 1896 with those of 1910.

All of these suggestions ignore some essential elements of the problem. There can be no relief so long as the more or less incompetent and improvident class remains as the preponderating element in our urban population. It is well known that at present births are more numerous in the poorer than in the better parts of cities and that the more or less dependent class increases with great rapidity. As long as this condition continues all suggestions for improvement will be worthless. The first aim must be to prevent multiplication of the class born to poverty.

When one advocates restriction of marriage, he finds himself face to face with bitter opposition based partly on sentimental notions, partly on supposed religious grounds and partly on inherited conceptions. He is told that marriage is a sacred thing; that reproduction is one of life's great duties, for God told Adam and Eve to be fruitful and to replenish the earth; and he is warned that by placing restrictions on marriage the community would encourage immorality.

The reference to Adam and Eve is hardly relevant to conditions of this day. If they were the only pair, they certainly had no reason to fear for the future; the world was theirs and there was ample provision for abundant progeny. They were in excellent physical condition and, being thoroughly repentent, they were well-fitted morally for parental responsibility. The plea that marriage is a sacred thing with which the state may not meddle is unimportant. The state does meddle and does regulate; even the Mosaic civil law regulated it; and the limit to which the state may go in regulation must be determined only by what is demanded for protection of the community. The plea that marriage is a sacred thing is made by the same pleaders who praise marriage as preventing "immorality"—not a very exalted conception of the purpose of marriage. But judging from reports of surgeons, there is no great room for increase of the vice, euphemistically termed "immorality"; but even if there were, the community would not be responsible for the result, any more than it is responsible for burglary and theft because it recognizes individual ownership of property. On the other hand, by permitting practically unrestricted marriage, it is guilty of encouraging still greater evil, the growth of a shiftless, feeble class with tendency to criminal ways and with prospect of little happiness.

Much has been said and written recently in favor of large families

and the cry is against race suicide. One is told that the early settlers of this land had large families and that the children were strong, physically and mentally. But they were a fine stock, and, like all pioneers, they were the best of their race—and natural selection came to their aid. Sheltered in only too well-ventilated houses and exposed to a severe climate, the feeble perished in infancy, the strong survived. No such selection exists in the class under consideration, which, unfortunately, lacks the original physique. More than that. Pure food laws, sewerage, proper construction of houses, sanitary regulations and the rest antagonize the operations of natural laws, whereby the sins of the parents are visited upon the children. Those who, under former conditions, would have died in infancy now survive the perils of the earliest years, in increasing proportions reach maturity, marry and reproduce themselves—a menace to the health and well-being of the community. The reports of surgeons employed by the New York Board of Education prove that a great part of the children in some portions of the city suffer from congenital defects, which, uncorrected by surgical treatment, lead to mental as well as moral deficiency; while teachers have discovered that much of the mental obtuseness observed in pupils is due to lack of proper nourishment. Quality, not quantity is all important in a population. It is said that a nation with stationary or decreasing population is in decadence and much ado has been made over the sad condition of France. Yet the thoughtful Frenchman is prompt to remark that he prefers 35,000,000 healthy, well-fed and contented Frenchmen to 100,000,000 of wretched Russians. It is true that in France war material is not increasing so rapidly as in some other lands; but the civilized world is outgrowing the notion that men should be bred as horses, to be killed in settlement of disputes which do not concern them.

It may be well enough for wandering savages, such as the Australian aborigines, to multiply heedlessly like rabbits and weeds, but it is not well enough in civilized lands where masses congregate in cities and the food problem becomes complex. Philanthropists, as they think themselves, would not prevent the multiplication of children, for that is a natural right of which man may not be deprived, even though he can not provide food for his offspring. The "cry of the child" is made the basis of bitter attacks on the constitution of society and demands are made that the state, whatever that may mean, should not only protect but also provide for needy children. In recent months, the pensioning of mothers left with children has been urged as the community's duty. An association for aid of the poor lately published in its annual report the picture of a despairing man sitting by the bedside of his wife and her newly born infant, with the query below, "And what will he do with the sixth?" A missionary out west with

seven children and a salary of $400 a year, awakened the deep sympathy of a women's missionary society. But the question arises at once and it will not down, Why should that helpless poverty-stricken man and wife have had a sixth? Why should that poverty-stricken home missionary have had seven? More than that—why should either of them have had any?

Philanthropic work, in endeavoring to ameliorate the pangs of poverty, begins at the wrong end; instead of trying to abolish poverty, it labors incessantly to increase it and its burdens. The improvident class procreates recklessly and would-be philanthropists encourage the folly. They are like men in a plague-stricken town, who endeavor to ease the pain of sufferers but refuse to recognize and to remove the sources of disease. Tenements are made better every year to protect the careless against their own negligence; public schools are inspected that contagious diseases may be checked; vaccination is compulsory and free; great dispensaries provide free treatment for all comers; women in confinement have free medical attendance and diet kitchens provide proper food for them; infants are cared for in day nurseries for a nominal sum that the mothers may go out to work; education, even professional education is offered to all, without cost. There is free treatment in the schools for children with diseases of the throat, nose and ears; effort has been made to secure in the New York schools free luncheons, free spectacles and free dental service for children who appear to need them; and it is reported that in the Chicago schools a fair beginning has been made, in that food for hungry children is provided at nominal cost.

Everything within the range of possibility has been suggested or attempted in order to free the improvident from all sense of responsibility for their offspring. Yet those who are guilty of this sin are the same with those who regale the community with illustrated lectures on the horrors of the slums. Philanthropy should begin its work at the other end; instead of endeavoring to alleviate the condition it should endeavor to abolish it. Instead of merely lamenting the fact that sewing-women's wages are so pitifully low, it should try to prevent increase of competitors for work, that wages may be better for the next generation. Instead of encouraging heedless procreation, its efforts should be to encourage restriction. The duty of parents to children should be made plain to those who are unwilling to recognize them; and indiscriminate free medical treatment should be abolished. Laws against child labor should be made more stringent and should be enforced rigorously; farming out of children should be made impossible. When it has been discovered that the community will not bear the expense there will be hesitation, and marriage of those without prospect of subsistence will be less frequent. Marriage of per-

sons mentally or physically defective should be illegal and increase of the criminal or vicious should be made impossible by aid of the surgeon. With smaller families, with better surroundings, all could be well fed and conditions favoring degeneracy in the young would be reduced to the minimum. This is not to say that only those in independent circumstances should marry; with constantly improving sanitary conditions everywhere and with work for all competent to perform it, the average expectation of life for a sound man would be itself a large capital.

It is true that restriction of immigration and severe regulation of marriage would not abolish poverty; the poor will be with us alway. Disease and disaster are liable to befal the best of men; temperamental differences will continue and men and women without good sense will be found everywhere. The dependent and vicious class will not disappear while the earth lasts. But the community would have done its best in one direction, at least, to prevent any but that unavoidable poverty, which demands not only sympathy but also beneficence.

MOTOR EDUCATION FOR THE CHILD

By J. MADISON TAYLOR, A.B., M.D.

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OPPORTUNITY is too often regarded, by parents and educators, as the equivalent of training. Many confident assertions are made to the effect that enforced educative measures for the very young child make for harm, and that spontaneity can be depended on to direct and sustain impulse. This would be true, perhaps, if parental wisdom could be relied on to provide thoroughly wholesome environment, normal suggestion and stimulus to varied activities.

Unfortunately, children are compelled to adapt themselves to diversities in environment which, in comparison to that of most domestic animals, is profoundly to their disadvantage. Problems of child-growth should be considered in the light afforded by customs prevailing among breeders of valuable animals. Among animals the young one is welcomed and the mother devotes herself almost wholly to its best interests, at least during the critical period of lactation and dependence. Thus an invaluable start is secured in the right direction, both in nutrition and in habit formation. How deplorably different are the duties of maternity as viewed by the large majority of human mothers only those of us who have spent years in the dispensaries for sick children, or have had other direct experience of the poor, can fully appreciate. The laborer must have his family near him because his home must be near his work. Small consideration is given to the problems of infants and youngsters who follow in the wake of household necessities.

Among breeders of animals the young ones are of paramount importance. They constitute direct assets and the utmost effort is given to develop them into salable products. The human mother must primarily serve as cook and purveyor of creature comforts to the wage-earning father. The animal mother gives her undivided attention to her offspring till it is able to act alone in accordance with its relatively higher capacity for independent functionation. Hence it is obviously important that at the earliest possible stage of human existence the individual shall be supplied with not only the best opportunities available, but intelligent guidance in motor development, in order that it shall maintain its sovereignty over animals, or itself become an efficient animal.

Fortunately, many human mothers are supplied with reliable instincts and solicitudes. The exigencies of city life tend overwhelmingly to vitiate primitive impulses, to subordinate such desires and capacities as make for development of the home; to change the nest, or

the hearth-stone, into a mere abiding-place, whence the least as well as the greatest must fare forth to earn money for necessities, or, it may be, for useless luxuries. It is true, the best motor education is supplied in the ideal home, on howsoever humble a basis, as that of the pioneer, the farm laborer, the small farmer. Here there is a constant supply of normal stimuli to action, made convenient and necessary by communal interests. Each one, to the youngest child, is called upon to do such things as lie within its capabilities, thus contributing proportionally to the common welfare. This, in its better aspects, can not be surpassed as an educative groundwork. The poorer city dweller, subsisting on ready-made foods and with no outdoors but the street, finds no scope for the primitive actions of digging, chopping wood, carrying water, hence can not develop symmetrically. Even among the well-to-do things are little better. The street, with its many perils from "devil-wagons," trolley cars, etc., is becoming more and more unfit for a playground. The schoolhouse yards sometimes provide space wherein the scholars can give vent to motor impulses, but at best these are wholly inadequate. Even the very rich city dweller is poor in opportunities in comparison with the country child, who has access to a bit of woodland and a farm-yard.

Look at any lot of city school children and you will find, with only moderate scrutinizing, a pitiable array of asymmetries, local weaknesses, evidences of inadequate development. They are handicapped from the cradle; weighed down with damaging tendencies to stoop, to slouch, to impair the chest, in which the heart and lungs must have space; to tilt downward the pelvis, which is the key to the nutritive organs.

No fuller argument is needed to establish my contention that all children, especially those of the cities, require not only ample opportunities to expand and develop, especially by exercise, as in plays and games, but also specific motor training to correct the perpetual tendency to minor deformities.

The most thorough method of acquiring both mental and physical efficiency is by systematic motor education. We may then outline how this can best be achieved. Always the play impulse should be encouraged. Amusement-games alone, however, often lead to listlessness, spiritlessness, impassivity, aimlessness, at best but negative qualities. Competitive games accomplish much more where there are able leaders to animate and direct action. The most educative factor is to stimulate the motor centers by enforcing precision of movement. A few exact movements conscientiously performed accomplish more for accurate coordination than hours of listless, half-hearted movements. Routine, monotony, repetitions, weary minds and fatigue bodies. Always it is the degree of spontaneity, the heartiness of response, the candor of cooperation, which make for progressive invigoration.

Hence the ideal educational agency, not only of gross motion, but

those modifications of motion, reaction-times, accuracy in eye, ear, voice, decisions, etc., is the game of ball and bat, or mimicries of chase and war, and such like spontaneous impulses to do, to fight, to achieve.

Many modifications can be made for the extremely young of either sex, *e. g.*, bean-bags, pillow fights, up to the medicine-ball, basket-ball, base-ball and cricket. All exercises of quickness and precision are exhaustive; hence they can not, or should not be unduly prolonged for the very young.

One of the best means of motor education is seldom employed in this country. This is training in posing, in imitating classical statues. My friend M. Laussat Geylin told me of an interesting competition he witnessed in a provincial French town. The teacher by this charming device trained a class of young peasants to such a point of physical excellence that they took a national prize. The plan is well worthy of wide imitation. Reflect for a moment how perfectly the essential conditions of balance, precision, full excursus, tension, steadiness, stretching, are thus graphically exemplified. Take the Discus Thrower, the Fighting Gladiator, the group of the Laocoon for extreme types of force; the quieter attitudes even require much of vigorous poising. D. A. Sargeant has written a book advocating the forceful simulation of a variety of common acts—rope pulling, javelin throwing, etc.

Vanity, always a powerful stimulus, is thus strongly elicited. The simpler Greek exercises were unsurpassed for inducing symmetry, especially when each side of the body was equally employed, *e. g.*, javelin throwing right and left, so too of the discus.

Always the left hand should be trained equally with the right, at least in educational measures. There is too much one-sidedness encouraged in tennis, golf, baseball, etc.

There may be objections to little tots attempting boxing or fencing, but it is entirely feasible and distinctly valuable for even young children to be taught wrestling. By single-stick exercises, symmetrically, I have entirely cured the effects of chorea, descending atrophy from cerebral paralysis, and the disablement of poliomyelitis.

Then again, the power and precision which follows resisting-exercises as taught by the Swedes (or better, as elaborated by a wonderful mulatto, Jeremiah Davis, who taught me amplifications of this rather tepid procedure) are really marvelous. Closely allied to this is the jiu jitzu of the Japanese (which I learned from a man who was for eight years chief of police in Nagasaki). The principle of the jiu jitzu is a series of tricks of fence and offence, taught the Samurai, to be employed when by any chance they were deprived of their weapons; and pretty good they are. A friend of mine, a great foot-ball hero in his day, characterized the method as "a series of nasty tricks to do your opponent dirt, which we Anglo-Saxons are taught to regard as unfair." They are not comparable in aggressive power to good boxing,

but have their uses, especially as a means of defence for women. Children readily learn them and they serve as excellent training in swift aggressions or defences for a weakling.

In swimming we have a perfect means of training in grace, symmetry and forceful movements. Every child should be taught this most valuable art almost as soon as it can walk.

Boxing may well be taught to little boys and little girls too; if for no other reason than to implant the power of standing firm on the feet under all kinds of difficulty. Curiously enough there is no means of teaching waltzing and guiding in a crush so good as the foot-work in sparring. Since it trains the whole body, including arms, chest and head (especially producing mobility and accuracy in placing the neck) and above all, since it encourages the great moral qualities of patience, good nature and self-restraint, sparring can be ranked among the most valuable of educational exercises.

Of the utility of dancing too much can scarcely be said in praise. It is safe to endorse the unreserved recommendation of a lady whose opinion in all worldly matters commands my respect, who asserts that no child has been properly trained until taught at least the simpler fancy dances, *e. g.*, the sailor's hornpipe and the Spanish fandango. As to "buck-and-wing" dancing, I can only say that it supplies much of value in many excellent directions, but savors of boisterousness overmuch for my taste. The same may be said even more emphatically of jig or clog dancing. Marching, military drill, with or without arms, both offer many valuable opportunities.

The modifications of these as employed by the Turnverein drills, wand and ring drills, "graces," all are to be highly commended when available.

In estimating the utility of any plan of education we should keep always before us the object to be attained. However useful the acquisition of knowledge, rules, principles, etc., may be, most, if not all our daily conduct is regulated by habits. The habitual processes, both mental and physical, become so strong that they dominate not only the individual throughout life, but also nations and races. Habits formed during one epoch impress the citizen maturing in that epoch. Another epoch and different groups of impressions alter points of view. This is peculiarly noticeable in religion as well as in fashions and industries.

Habits are motor modifications in nerve substance, which gradually become stable and accurate through repetition of actions, whereby they grow more easy of performance. Thus is memory made the product of countless actions which have been performed many times before. Hence we remember most easily sense-impressions most frequently received, or acts most often performed. Thus many nerve-paths are developed in brain-cells or fibers, also shorter and easier routes are acquired, through connecting or association structures. Thus habit

constitutes organic memory, which may or may not be accompanied by active consciousness. They may be good or bad habits.

It is obvious that this store of working habits, mental and physical automatisms, must be acquired as early and as correctly as possible, so that the essentials of education shall be abundant, varied and precise; and then we may combine and elaborate them as we grow in age and facility. When the time comes to specialize in any direction we have need for an equipment in all the simpler automatisms, that we may group them unhesitatingly to form the basis of our later adaptations.

It is in the last degree unfortunate if our early habits, dynamic associations, are not sufficiently varied and exact to confidently assume precision in responses when we need them as conditions for those specializations which later constitute our life-work.

To attain useful facilities in any line of human endeavor the training of the senses should be systematically pursued from the earliest manifestations of attention. Sense perception opens up the way to form concepts of objects, but is of use only when supplemented by motor impulse. Every normal sense impression tends to pass into movement, and is of use only in so far as it does so; in short, conditions for motor development depend upon sensory impulses.

Mental visualizations, interpretations of images, concepts of form, can arise only through motor outflows. Ideas are of potency in proportion as they include the elements of motion, the impulse to do.

Thought is a word much in use, but the act of thinking is by no means a constant process, even with the most intelligent. Much of what is called thought is, in most instances, merely automatic action aroused by some sensory impulse. To think deeply, to exert intellectual force, is rarely needed in the day's work; but every human being has constant need of myriad accurate automatisms, the product of early and varied associations of sense impressions along with muscular acts. The product of these is the idea, the memory image. When rightly formed, full reactions between observations and applications they become unerring guides to conduct. They serve most of life's purposes and are absolutely essential, are become, in the main, dependable. Promptings must, of course, be incessantly modified by intelligent inhibition, the checking of over-action, judicious selection of courses of action.

Whatever the direction that life-work may take, that child is especially fortunate who is compelled to acquire a store of motor reactions long before the reasons for them are understood. This essential equipment is only to be secured during the period of plasticity, while the tissues, brain-cells, nervous mechanisms, etc., are elastic, impressionable. After this period, which slowly subsides, passing gradually into varying degrees of adaptability, the formation of new yet efficient automatisms becomes increasingly difficult.

THE CASE OF THE COLLEGE PROFESSOR

By Professor WARNER FITE

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ONE of the recognized subjects for public commiseration at the present time is the college professor's salary. Once in so often some disgusted member of the profession writes a letter of protest to his favorite weekly journal and starts a new wave of sympathy. Yet so far it has occurred to none of the complainants to propose, as a serious measure, the policies by which other men have bettered their condition—for example, the policy of organized self-assertion expressed in the trade-union. In the eyes of the profession the bare suggestion is vulgar. The aims of the scholar and teacher, as he will have you know, are essentially disinterested. His work in the world is that of a missionary working for others. Or if the "others" sounds too evangelical, at least his motives are those of professional honor. It is therefore out of the question for him to make any very overt demand for increased compensation. Rather is it the business of society to recognize the delicacy of his position and see that he is properly rewarded.

Yet there is something incongruous in a missionary complaining of his pay. The missionary is supposed to be delighted with hardships and to find ample satisfaction in "the beauty of self-sacrifice." If, like other men, he thinks that he is also entitled to a fair living, then it is not to be seen why the duty should not rest upon him, as upon others, of presenting his account. The college professor may plead in excuse that for him the business of settling accounts is specially troublesome. And it is true that his work calls to a special degree for freedom from distractions, and that to the problems upon which he is engaged questions of compensation are external and immediately irrelevant—while for the business man distractions are the ordinary routine and higgling for higher prices the game in which he delights. Unquestionably, in the interest of the college professor's work, it is desirable that his economic welfare be reasonably secure. Yet if the professor's furnace fire goes out, and no one is at hand to attend to it, he must set about it himself or freeze. By the same token, if society fails to attend properly to his salary, the responsibility rests upon him. And in the end this is the place where the responsibility should rest.

It would make this responsibility clearer if he would frankly ask himself what, after all, he is really standing for. And if the question

were once plainly put, he would be compelled at the outset to abandon the illusion of "missionary work." The missionary idea presupposes the poor lad with a keen thirst and capacity for knowledge to whom the college doors are closed. This pathetic image has long ceased to represent any substantial reality. If any such lad is still unprovided for, a hundred college presidents would be delighted to make his acquaintance. As the case stands to-day, it is the colleges who are competing for students and not the students for admission to college. Like the life-insurance companies, the colleges are expending a large part of their energies in securing "new business," and their criterion of progress is the life-insurance criterion of numbers. If the catalogue shows no increase of attendance over last year, the year is counted as lost; and in the matter of attendance everybody counts for one, no matter what kind of a one. "The harvest truly is great, but the laborers are few" —nothing could be further from the truth at present in the field of higher education. So insufficient, in fact, is the supply of ripe fruit that many of the laborers are gathering stalks.

Nothing better measures the active demand for higher education —for *education,* and not for college degrees—than the prevailing academic standards. A few years ago out of a class of forty in formal logic I conditioned ten. A colleague, commenting upon the fact, remarked that "the mortality was rather high"—in which, of course, he was correct. Yet, as I felt called upon to say to the class (many of whom were students of law), if they had been defending themselves by their own logic in a trial for their lives, not half had escaped being hanged. And had they been making shoes, not half the product would have been fit to wear. Think of a factory where the workers receive full wages if sixty per cent. of the product is marketable! Or of a physician who makes a false diagnosis in four cases out of ten! Yet sixty per cent. is the usual academic standard; and, as this standard is commonly interpreted, a student receives credit for the course if he answers correctly six questions out of ten—not *test*-questions, be it noted, but "fair" questions. Similar standards prevail in other matters. Many colleges put up with a laxity of attendance which is unheard of in an office or factory. If it be asked why academic credit should be earned more cheaply than dollars and cents, the answer must be in terms of supply and demand: the supply of student material which would satisfy the standards of fitness that prevail elsewhere is insufficient to meet the colleges' demand for numbers.

In the presence of these conditions, "missionary work" becomes a mere euphemism for academic inflation. And nothing has been more fruitful of corruption in academic life than just this policy of inflation. Nothing has contributed more to lower the college in public esteem or to obscure its purpose as the promoter of serious thinking. In

the interest of increasing its numbers every intellectual ideal has been compromised, athletics have been made the determinants of college policy, and college life has become a carnival of "student interests." Nothing, however, has done more to depress the salaries of professors, and at the same time to cheapen the type and character of men considered eligible to the profession. To this, indeed, we owe the preference over the scholar, the student, and the teacher, of the academic *entrepreneur,* or "educator." It is most noteworthy that the Carnegie Foundation, in its search for the obstacles to the advancement of teaching, has landed upon this point first—namely, the cheapening of salaries and of men which comes from reckless expansion. And it is not pleasant to reflect that, while the laboring man is prepared more or less to stand for himself, the function of a trade-union for college professors is left to Mr. Carnegie's foundation; or, further, that the college professor, while eager to share in its benefits, has shown thus far no very hearty sympathy for the purposes of its investigations.

For, in the end, it is the college professor himself who is largely responsible. I doubt if many college men fully realize the intimate connection between the policy of inflation and their own economic position. Most of them are as naïvely enthusiastic over a gain in attendance as a student over a foot-ball victory. And when it is otherwise they are content to lay the burden of responsibility upon the head of "the administration." It is not my intention to absolve the administration; yet there must be few cases where the choice of the administration is not more or less determined by the faculty themselves. In any case, a hostile administration could not long survive a serious and well-considered opposition. As President Schurman says in his last annual report, "A faculty will not be dominated or over-ridden which justly asserts itself." It must always be remembered that, with the exception of the president, the only persons who are with the college all the time, and whose interests are continuously identified with its welfare, are the faculty. And they are the professional experts. Consciously or unconsciously, positively or negatively, they are bound, therefore, to have a large influence upon its policy.

In the matter of inflation they have been more than negatively responsible. Under the opportunities for competition afforded by the elective system, nearly every professor is struggling to magnify the importance of his courses by increasing the attendance. He knows that, under the present conditions, attendance will count for promotion, and further that a large attendance is incompatible with very severe standards; and he finds it easier to conform to the conditions than to raise his voice in protest. Likewise every head of department is striving to make his department the largest, to print the longest list of names upon the department letter-paper, without regard to quality or

price. The net result is to strain the financial resources of the institution almost to bursting, and at the same time to lay the foundation for such an increase of fixed charges as to bar all possibility of a more liberal scale of salaries.

In all this the college professor is apt to congratulate himself upon the wisdom of the serpent. The argument of numbers, he will tell you confidentially, is to impress the imagination of legislatures and millionaires, and when a comfortable establishment has been secured, of course all will be changed. But, apart from the fact that the wisdom of the serpent is not the scholar's special brand, and sits not well upon him, if every increase of resources is to be paralleled by a corresponding increase of liabilities, in the form, say, of new departments to maintain, it must be said that the college is playing a losing game. In the meantime there are few, at least of the better institutions, which could not be financially independent on the strength of their present foundation, if only they would have the courage to curtail their product in favor of a better grade of goods. If standards were raised to approximate those used elsewhere, if college education were presented as a privilege, to be reserved for those who will work for it, if the college would determine for itself what it can profitably offer and what the student can profitably take, instead of aiming at a department-store assortment of electives, it would improve its own dignity, increase its real usefulness, and at the same time be able to make a more liberal provision for its faculty.

Inflation of attendance is, however, only part of a general program of extravagance and improvidence. The popular theory of academic finance is the theory of the deficit. Nowhere else is it considered a mark of economic wisdom to spend beyond your income. In the college it is held to be a necessary condition of health and "life." And for the necessities of "life" it is assumed that the Lord will, and will thus be compelled to, provide. At the same time the furnishings of life have acquired a larger importance. It is no longer a matter of Mark Hopkins and a log, but of the log and Mark Hopkins. Remembering that the chief factor in teaching is the personal intelligence of the teacher, it must be said that the salaries of instruction, as compared with the other expenses of maintenance, cut a surprisingly small figure in the budget.

Here again, however, the college professor is largely responsible. Some allowance must be made for the necessary equipment for instruction in science. Yet even here, and perhaps specially here, it is true that too much emphasis is laid on the laboratory and too little upon the man. It is apt to be forgotten that many of the greatest scientific achievements have required only very crude instruments, and that, after all, the aim of science, as of philosophy, is, in the words of Hegel,

to be a *thinking* study of things. The fact is that it hardly occurs to the college professor to ask what he can do with the means at his disposal. The same man who, in his household budget, is careful to ask what he can afford, urges the demands of his department upon grounds of absolute necessity. A two-thousand dollar professor will insist unblushingly upon a two-hundred-thousand-dollar laboratory. And by dint of urging and begging he may get it. Of course he thinks that his salary will rise to correspond. He is then much chagrined to discover that what might have been added to his salary is needed for the maintenance of his laboratory; and the responsibility is laid upon "the administration."

All of this goes to show that, in spite of the theory of "missionary work," the activity of the college professor is not a purely altruistic response to a crying need. To this it may be replied that it is precisely in accordance with the missionary idea to endeavor to create the need. All very true, perhaps, but just this may be claimed for every line of business, for jewelry and millinery as well as for preaching. In fact, "missionary work" is one of the stock-features of the slang of advertising. The real question has to do with the nature and significance of the need you are endeavoring to create, whether it be a need for college life and academic degrees or for culture and serious thinking. Whichever it be, it would be profitable for the college professor to recognize that, like men in other trades and professions, what he is endeavoring to create is at any rate a need for himself. In other words, he, like other men, is aiming to develop a field for his own activity. Now he is none the less to be respected for this. Rather do I think, the more. Nor does this lessen the social value of his work. If his work have a genuine intellectual content, it is bound to be worth while, for others as well as for self. The point of criticism is not that the college professor works for himself, but that his self-seeking is so persistently unintelligent; not that his "missionary work" conceals ulterior personal motives, but that these motives are allowed to remain ulterior and to express themselves in ways so ineffectual and so little in accord with the dignity of his profession.

What the college professor needs, then (paradoxical though it seem), is a self-consciousness of his position. He should make it clear to himself that, whatever be the social significance of his aims, he is working at the same time, like other men, for the satisfaction of personal ends, among which is included a satisfactory provision for his living. He should then take upon himself the responsibility of doing openly, deliberately and intelligently what he is now doing covertly and blindly, without cooperation or organization. To this he commits himself by his present attitude. Upon him, then, should rest the responsibility, both of formulating his case and of using the means at his disposal

to secure the satisfaction to which he conceives himself to be entitled.

Now when the question of title is raised, he is quite likely to be reminded that his occupation is a rather pleasant one and possesses many features very delightful to a man of scholarly tastes. We need not deny this. In fact, if the college professor is not to lose an important part of his case, it would be well to remember that his demands are not for bread alone. But the beauties of the professorial life are such for the academic man; for the average business man the life would be intolerably dreary. And in this respect, that there is a certain correspondence between work and tastes, the occupation is singularly like many others, and it is not to be seen why the profession of teaching should be specially penalized. It is all very well to talk about "plain living and high thinking." I admit that it is not for the college professor to aim at the pace set by fashionable society. But I can see no virtue in plain living just for itself. Its only value for the scholar is to leave the mind free for high thinking. And if living is too plain, the result may be easily the reverse. Such, in fact, is the present situation. Few college men would be "living high" at twice their present salary. Indeed there are rather few cases where this would constitute more than a properly liberal allowance for the best "performance of function."

But the question as I am endeavoring to state it is not primarily one of abstract justice or social function. It is the more direct question, addressed to the college professor, namely, What are you going to do about it? How are *you* going to make your claims good? As the question is often put, it takes the form of a dilemma: on the one hand, the dignities and privileges of a learned profession, if you will accept a life of poverty; on the other hand, a better chance of a comfortable living, but no opportunity for the things that are specially dear to you. Choose and remain silent, for you may not have both. But most disjunctions are fallacious, and valid only for the stupid. If the college professor is as intelligent as he claims to be he may refuse to accept the choice of alternatives and assert his intention of securing for himself both a liberal living and the opportunity for an intellectual life. And he will do so, as I have suggested, by applying to his own case the principle of organized self-assertion which is illustrated in the trade-union.

The mere suggestion is too much. Imagine, if you please, a strike of the college faculty for an eight-hour week, a cordon of police about the university, the professor of education, as walking-delegate, puffing a black cigar into the president's face, while "scab" instructors, supporting a family on a thousand a year, are teaching depleted classes in fear of their lives! Yes, but why imagine all this? I am speaking presumably of the self-assertion of intelligent men, of men, indeed, who claim to embody the highest intelligence of the community. And

I am standing, not for trade-union methods, but only for the trade-union principle, namely, the principle of self-assertion. If your college professor can assert himself in no better style than the labor-union, his intelligence is an illusion and he has no case. The working man can conceive of no way of bettering himself except at his employer's expense. In his view there is a fixed margin of profit between a fixed cost of production and a fixed market-price, and what is added to wages must be deducted from profits. And having no personal authority, by virtue of education or social position, he can conceive of no way of asserting his claims without the exercise of economic pressure or physical force. It should be the aim of the college professor to prove, in ways already suggested, that he may indefinitely better his position, not at the expense of his college, but in the very process of making it a more worthy and influential institution; and that for this the chiefly potent force will be the authority of his position and of the argument that he is able to present.

But for this purpose it will be unnecessary to form a special organization. For the college professor is already organized. Practically every member of the profession is a member of a college faculty and also of one or more learned societies. The latter, of course, as associations of men united by the interests of a special line of work, bear a nearer resemblance to the trade-union; and they would not be going out of their way if they should include the advancement of the scholar in the advancement of learning. But for our immediate purpose the college faculty is more important. For as a member of the faculty the college professor already holds a franchise of considerable possibilities, and a place where he is authorized to speak, where, indeed, he is responsible for expressing himself regarding the welfare of his college, and where, as I think, he may also rightfully represent his own claims and those of his order. Simply to make a responsible use of his official prerogative would go far toward improving his position. And if the college professor is ever to assert himself, this is the place to begin.

For this in fact is the point at which he is most conspicuously weak. Nowhere does he appear to less advantage than as a member of the faculty in faculty-meeting. It may be doubted whether any other assembly of men indulges in more ill-considered talk and more ill-considered action than the average faculty. Men who habitually talk sense seem here to talk nonsense. They advance confident opinions on matters that they have never considered; on the spur of the moment they offer motions, often of a far-reaching import, whose meaning they are afterwards unable to explain; they entrust special business to committees and then ignore the committee-reports; and they constantly illustrate the law of action and reaction by reversing at the next meeting the measures of the last. The fact is that the individual college

professor, however responsible in study or class-room, has as a rule little sense of the dignity and responsibility of his office as a member of the faculty. And it is also true that many men are admitted to our faculties who, by reason of inexperience and immaturity, or of constitutional lack of culture and self-respect, should not be entrusted with the office. Nothing better demonstrates this than the fact that measures pass to which a large majority are heartily and sincerely opposed —measures which, it may be, are clearly to their disadvantage. Let it be known, however, that the measure is the president's own, there will be few to vote against it, almost none to speak against it. The majority conceal their want of frank courage under a Pickwickian conception of "loyalty."

Thus it has come about that the seat of authority in college matters has passed to a large extent from the faculty to the president, who, then, by analogy with commercial ideals—to which college men are often curiously deferential—has been invested with the character of captain of industry. Now the captain of industry may be necessary in the business world, where, perhaps, most men are fit only to be led. And I do not doubt that the modern college will need an executive head, whatever be his relations, on the one hand to the trustees, and to the faculty on the other. But that the college professor should himself adopt the *entrepreneur*-theory of the office, as he frequently does, and should even glorify "the rule of the strong man"—over himself, can stand only for an utter contradiction between the idea of his profession and its present actuality. In a word, it is an incredible attitude in one who believes himself to be a scholar and a gentleman and who attaches any moral significance to the fact. If the democratic principle is to hold anywhere, it should hold here. But it can hold nowhere unless men have the courage to say what they mean and a responsible meaning to express.

Accordingly, as the first feature in the program of self-assertion, the college professor should seek both to strengthen his authority as a member of the faculty, and as such to secure for himself a more comprehensive representation in the government of his university. In this, while cooperating with the president and the trustees for the welfare of the institution, he will at the same time act with an explicit reference to his own. There is no reason why the attitude of any of the parties to the situation should be purely impersonal. The welfare of a university is represented in the fulfilment of the numerous interests which it may be conceived to represent, and these interests are in last analysis personal. The aim of college policy is their coordination, and in the college especially, a broad computation of each should leave little margin for dispute. But if all computations are to be impersonal there will be few suggestions of value to interchange and few data either for

the problem or its solution. And if the college professor is to be represented anywhere, it should be by himself.

Hence, there need be nothing in faculty representation which is invidious to the rights of either president or trustees. And there is reason to believe that responsible representation would in many cases be welcomed. To quote again from President Schurman's last report, "No greater good could come to Cornell University than a quickening and deepening of the faculty sense of responsibility for its welfare. Too often the faculties of American universities have rolled all responsibility on the president and trustees." And later he adds, speaking of the relations of the faculty to the executive officers, "It is for them [the faculty] to keep the institution democratic. And nowhere else is democracy so important as in the university."

Then, secondly, as embodying the point in which he is most directly interested, it should be the aim of the college professor to have all academic appointments made publicly, with sufficient time allowed, if possible, to secure the consideration of all available candidates; and to have the list of candidates submitted for consideration to a committee of the faculty, chosen by the faculty themselves; and further to include in this policy the matter of salaries and promotions. I know that at this point gentlemen will cry, Politics! Politics! But it must be remembered that politics open and aboveboard is no longer "politics." There can be no "politics" except where there is secrecy, as under the present system of pocket-appointments.

Thirdly, however, it should be his aim to have the general features of the budget submitted for consideration to a similar committee of the faculty. At present the budget is supposed to lie wholly beyond the faculty's domain. Yet there are few questions in which it is not more or less involved, from the granting of a scholarship to a new system of electives. In the college, as elsewhere, it is a question always of what you can afford. And what you can afford is a question of the various alternatives. If the faculty are to act wisely, either for themselves or the college, they must know the financial possibilities. And if the trustees are to spend wisely, the recommendations upon which they act must have had these in mind. Under the present system of non-communication expenditure is too often footless. And nothing has done more to discourage the faculty sense of responsibility than the feeling that only part of the situation is shown them and that the president holds a card up his sleeve.

Finally, in the interest, both of himself and his profession, he should insist upon a high standard, both of scholarly attainment and of personal culture and responsibility, for academic appointment; and especially should he insist that membership in the official faculty be restricted to men of rank and maturity. In other words, like the labor-

ing man, he should seek to protect himself from irresponsible competition. And if he is to stand for himself, he must stand for this above every thing else. For in the end the force upon which the college professor must chiefly rely is the authority of his character and his profession.

The program thus outlined would imply an eventual readjustment of constitutional rights. But it need not wait for this. The main point is that the college professor should undertake to speak in matters of college policy, both for himself and for the college, and that he should then secure consideration of what he has to say. If this is accomplished, he can afford to wait for recognition by law. For, after all, nothing is so potent as a reason, if only it can get itself considered. And none should be able to offer a better reason than just the college professor. His reason once formally made public, few presidents or boards of trustees would care to turn him down without a very good reason in reply. One of the sharpest contests in the history of college politics was over the question of a veto. The president had an unlimited power of veto over the action of the faculty—could he ask more? Yes, a little more; he might disregard the faculty's vote without committing himself to a veto. And this was the sole point in dispute. What it meant was that the president cared not to appear before the university and the public with his faculty's support withdrawn.

The program of self-assertion imposes upon the college professor a considerable increase of responsibility. If he is to be responsible for himself he must also assume a responsibility for his college. And to responsibility he is commonly adverse. But upon him the matter rests; and if he declines, he should forever keep silent about the narrowness of his conditions.

THE CONSULTING PSYCHOLOGIST

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TO the popular mind the "consulting psychologist" is a medium in the rookery on Broadway to whom one may go for paid advice—decidedly practical. But the meaning ascribed to the term by Professor Royce, in his now classic address before the National Educational Association, twelve years ago, has perhaps found some recognition. It is in this sense that I shall use the term.

With the growth of science comes the specialist, and with the development of the specialist comes the consulting specialist—a man who does not engage in competition with the rank and file of the profession, but conserves his energies and fits himself for dealing with special problems. In the past the consulting practise has generally come as a result of preeminent success in ordinary practise, and from a desire to select the most important work. This is illustrated in medicine and engineering. But with the passing of the self-made man, and with the growing differentiation of work, comes an opportunity for the trained specialist, still young, to get recognition for special service. In all the branches of medicine and engineering, and in many other fields, there is now a demand for the man who is master of something specific. Now, as psychology becomes a science and so begins to show signs of being of practical value, there is more and more demand for men who have not only a thorough mastery of the subject, but who will devote themselves to some aspect of its application.

We are just now at an epochal turning point in psychology. The subject is passing its infancy as a pure science and the world has taken us all too seriously in the promise of what we can do to be useful. We stand amazed in the face of the confident and insistent demand from the various walks of life for psychological principles of explanation, organization, guidance, economy, efficiency, conservation, expansion, growth, evolution, development, transference, impression, retention, elaboration, attention, affection, action, fatigue, rest, etc. The demand comes from the arts, the sciences, the professions and the industries, as well as from the patrons of liberal culture. Education as a science knows no other foundation equal to psychology; fine art, in all its branches, is interpreted in terms of psychology; social, charitable and corrective agencies grope for psychological justification in every movement; medicine, as it faces the bewildering ills of mental life, recog-

nizes the necessity of a psychological point of view and technique; law has caught a glimpse of the fact that it has to deal with human nature; the ministry has hit upon the fact that the soul which is to be saved and made like unto the divine is the human mind; the merchant has discovered that impression, attention, interest, satisfaction and action in salesmanship can be enhanced by knowledge of the laws of human nature; the manufacturer is beginning to realize that skill, invention, economy of process, etc., can be improved by knowledge of the nature and laws of the psychophysic organism; the great wave of interest in the conservation movement which is sweeping over this country reveals the fact that the most serious depredations we have to check are the inroads upon the human mind, and the most precious resource which the country has to conserve is the mental energy of the race; preventive medicine and eugenics invoke the science of the mind to decrease ills and increase power, happiness and beauty of mind.

In short there is a very great demand for applied psychology. The world believes in it. What, then, shall be our attitude toward this demand? I venture to suggest a point of view in the following four propositions:

1. The facts of psychology are fast becoming common knowledge which will profoundly influence thought and action. Men in all walks of life will apply their knowledge of mental life; but, be they ever so well grounded in this science, psychology is not their calling, and they will treat it merely as one of many points of view in their broad outlook.

2. All psychology is more or less practical. The psychology of the class-room is not a mere decorative frill, and we are not all the time tuning our fiddles in the academic laboratory; but the primary aim and ambition in all is academical, and it should be.

3. Research in pure science is farsighted, and thus ultimately of the greatest service. The work must be fundamental. This is its chief merit and distinguishing trait. If the investigator who gave Marconi the principles of wireless telegraphy had aimed directly at the saving of ships at sea, he would probably have failed; but he devoted himself to the mastery of an abstract principle and laid a large foundation. Countless achievements may be built upon this foundation.

4. There remains a distinct field for the consulting psychologist, an expert in psychology who may be employed as adviser in matters pertaining to the ascertained facts of mental life with reference to their bearing upon a given practical situation, or may be employed to search for or verify such facts by special investigation. He is the Marconi of psychology; the man who works out the application.

For convenience we may divide the field open to the consulting psychologist into four large divisions, namely, (1) mental pathology,

(2) education, (3) technical arts, crafts and professions, and (4) eugenics. This classification is not all-inclusive nor are the divisions mutually exclusive, but some such divisions may be helpful in blazing the trail.

The first division embraces all institutions for those who deviate from the normal condition of mind; such as insane asylums, schools for the sensory defective, institutions for moral delinquents, homes for the feeble-minded, epileptic colonies, the provision for the abnormally retarded and mentally defective in the public schools, and special schools, clinics, foundations, laboratories or retreats for the study and treatment of mental deviation. As the physician is at present more in demand for the curing of disease than for preventive measures, so the psychologist's first mission will be to the mentally suffering. The alienist will share his duties with the consulting psychologist; the superintendent of the charitable institutions will be guided by his advice to a large extent in organization and management of institutions; the segregation of mentally defective pupils in the public schools will be under his supervision; and, in the special institutions for the investigation of mental troubles the psychologist will, of course, be the central figure.

The second division embraces the vast field of applied psychology in the organization and administration of the education of normal individuals. This does not refer to the work of the professor of educational psychology, nor to the psychologically trained superintendents, principals or teachers, but to the experts who are available for consultation work only. The consulting psychologist will be found in the research laboratory of educational psychology, in the research laboratory of other educational agencies, in the office of the city board of education (or in the superintendent's office), in the office of the state superintendent of public instruction, and in the national bureau of education. We have recently heard the assertion that the railroads of a certain section of the country could save a million dollars a day by scientific management; but it would be less hazardous to say that the patrons of the public school system of the country could save a million dollars a day by the introduction of psychologically scientific management of instruction. The principle is the same, and the one measure is as tangible as the other; neither has been solved and neither is the task of a day; both are progressive measures. The first thing essential is that the administration shall have faith in the aim and effort of the expert; and second, that the expert shall be willing and able to make good. Both are in sight. If the money now paid to authors of children's first books in reading were paid to a group of experts for a dozen years some fundamental principles of mental economy in learning to read might be worked out so as to be of permanent guiding value to authors and teachers of primary

reading. As it is, the psychologist who to-day is the greatest authority on the psychology of reading, and who has done more on the subject than any one before him, has merely nibbled at the subject for spare moments, in the midst of an otherwise busy career. One such man alone devoting himself to the subject for a lifetime with suitable facilities at command could accomplish wonders. Or, take the subject of arithmetic. Would it not be good economy for the national bureau of education to employ a dozen experts for a dozen years with adequate facilities for experiment and consultation to work out some principles which should determine the elemental contents and fundamental methods of a child's first book in arithmetic? The absence of such principles is notorious. As the promoters of the automobile, the flying machine and countless other enterprises are now watching the work of the electrical chemist in his struggle to invent a new battery for the storing of electrical energy, so the eyes of the educational world will be upon the man who goes into his laboratory, surrounded by all the aids his science can furnish, in systematic search for ways of conserving the mental energy of the young in school so that a new order of things educational may become possible. A young man of marked ability having to choose to-day between the plan of devoting his life to the intensive study of one practical psychological problem, on the one hand, or the academic career as a teacher, on the other, may well choose the former as the more promising of permanent contributions to science for the good of mankind. As the well-qualified men appear, positions will be created for them providing for their bread and butter.

The third division embraces a great variety of situations in which the consulting psychologist may be employed in determining courses of action, principles of efficiency, principles of economy, principles of validity, etc. Thus in manufacture, there is constant waste of human energy for want of knowledge of underlying mental laws which might be applied for the improvement of the type of mental activity involved; *e. g.*, for shortening or simplifying movements, for facilitating perception and discrimination, for enhancing appreciation, and for increasing the effective output of energy. The lawyer has abundant opportunity for seeking expert information in regard to the laws of human nature. In medicine the present movement in psycho-analysis is an illustration of the opportunity for detailing a trained psychologist to work out the case by technical methods which require much specialized skill. Advertising which now employs very high-grade writers and illustrators appeals to psychology for fundamental principles in regard to the work of attention, feeling, satisfaction, convincing argument, etc.

The fourth field really belongs to a future generation, for, although we are seeing it full of promise, eugenics, the welfare of mankind, is to us as yet quite unfathomed. The improvement of the race, direction in

the choice and preparation for a vocation, social adjustment, the scientific reduction of crime, and the increase in the sources of human happiness—these are all possible, but distant goals of applied science.

To illustrate more specifically the work of the consulting psychologist in one type of situation, we may take the first field of the four just outlined, namely, mental pathology, bearing in mind that the functions may vary greatly with differences in men, institutions, times, etc.

The consulting psychologist in institutions for mental ills has two fundamental types of function; one that of advice, and the other that of research. Both are necessary for encouragement and growth of the man himself and for the good of the institution. In the capacity of adviser, he may be expected to place at the disposal of his superior officers the latest gleaned and verified facts and theories on the issue in hand and to lend such aid in their adaptation and introduction into the routine of the institution as circumstances may permit; and in the capacity of investigator he may direct, or personally conduct, research for the solution of pending problems. Thrown into tabular form his duties and privileges of advice and research might be listed as follows:

I. *Advisory.*

1. Testing, classifying and sorting cases on admission.
2. Planning and utilizing the case history.
3. Systematic observation and experimenting on the progress of each case.
4. Adapting treatment, training and adjustment.
5. Technical instruction to the staff.
6. Education of the public (information in regard to preventive measures).

II. *Research.*

1. Original experiments on the value of new types of treatment, training and adjustment.
2. Intensive study of individual cases.
3. Search for needed psychological facts by scientific experiments.

Thus, on the advisory side, he aids the superintendent, the staff and the public by making known and adapting applied psychological principles; and, on the side of research, he tests results of procedure in scientific terms, is ever alert for the discovery of instructive cases which may come under his observation, and directs psychological research for immediate practical purposes.

Perhaps the nature and scope of the work of the consulting psychologist in this illustration from mental pathology may be further specified by pointing out some limitations in a negative way.

The consulting psychologist is not a general administrative officer. There is, perhaps, no better training for a superintendency or other executive work in this type of institution than psychology; but, as in

business, if the stenographer becomes president, he gets another stenographer; so here, if the consulting psychologist goes into executive work, let him get another consulting psychologist; for, even if the superintendent be the best trained for expert work, his duties are of a general administrative sort and he can not afford to devote himself to the details of technical work. And if the psychologist is to be successful in the long run, it is desirable that his ideas shall pass muster in the superintendent's office before they are put into operation in the routine of the institution. The temptation to undertake executive duties and to infringe upon the rights of the executive is a natural stumbling block, for it is human nature to reach out for power especially when there seems to be a crying need for its exercise. The consulting psychologist has come about as a result of the differentiation of function and he will find himself permanently only as he recognizes that he is a specialist and limits himself to the work of advice and research within a narrowly limited field, respects the dignity of his calling, and covets no other.

The consulting psychologist will not dissipate his energies in general psychology. While a broad training in theoretical and experimental psychology is the best asset with which to start the career, his success as an expert will depend largely upon his willingness to steer clear of pure science problems and his determination to devote his ingenuity and best energies to the adaptation and application of facts already known. There is a constant temptation to evade tasks of achieving something practical for the pleasure of browsing in the green pastures of all knowledge. Like Edison he must stick to his beakers and batteries even at the expense of public ridicule.

The consulting psychologist does not yield unduly to pressure for results. One of his chief duties is to forestall the precipitous rush into extensive application of what may be at best but a specious principle. He will dare to say, "I don't know," even if it should take him years to search for the seemingly trifling fact. While we but little dream of the possibilities in command of applied psychology, there is in the present atmosphere entirely too sanguine a feeling in regard to what it can do on short notice. Instead of being hazardous at guessing, the consulting psychologist must have courage to demand that he have the privilege of making patient search before he prescribes. Thus he has to pass through the narrows with the danger of dissipating his energies in aimless search for truth for truth's sake, on the one hand, and, on the other, the danger of hasty and ill-advised rush into practise.

The consulting psychologist is not a reformer. People think that he holds the magic wand and can transform situations suddenly. If inexperienced, he is likely to enter upon a program of reconstruction, for all seems wrong; but, as soon as responsibility is placed upon him

for the consistent readjustment of one particular little feature, he will tone down, haul in his flying colors, and investigate the ground on which he stands. He may even go so far as to feel that whatever is is best under the circumstances. Here is where his mellowness of experience, knowledge of men and evolution of institutions, and his practical sagacity will be tested. If he is shrewd he will progress slowly and by such steps that both he himself and his superiors may acquire confidence in his work. At the same time he will miss no opportunity of making himself useful in a tentative and provisional way.

He is not a practising physician. While a medical education is most desirable he must have a really different point of view from that of the practising physician. In the first place, he observes and recognizes the mental half of man in a way in which the institutional physician does not; and herein lies his mission. His place is to supplement the work of the physician.

He does not surrender his scientific freedom. With all these restrictions he must demand one great privilege, the freedom of a man of science. Unless he is given time for patient and deliberate search, freedom from necessity to rush into print, exemption from excessive routine duties, reasonable physical equipment and assistance, he can not grow into that scholarly attitude which is necessary for effective work and results on a large scale.

What then shall be his training? Applied psychology is more difficult than pure psychology, if such there be. The consulting psychologist must, therefore, like all consulting experts, come with high qualifications. In the first place he should have the laboratory training in psychology which would correspond to that required for the doctorate in order to get thoroughly impregnated with the spirit of research, but this graduate work could profitably be planned with reference to the field he is to enter. Then he must have knowledge of, and training in, that phase of work which he is to pursue, such as education, medicine, sociology, etc. And in addition to this academic training he must go through a process of apprenticeship in the field before he is qualified for the most responsible work. But he will be a university product in the best sense, and the universities must rise to the recognition of this opportunity for usefulness.

Just one concrete illustration of what a consulting psychologist is doing now in the way of scientific adjustment in an institution. In the New Jersey Training School for Feeble-minded, at Vineland, Dr. Goddard, in most hearty cooperation with Superintendent Johnstone, has carefully graded the children by the Binet method; *i. e.*, he has determined the age of mental development and capacity, as opposed to the physical age. The children are then kept under systematic observation by the staff and record is made for the purpose of establishing

norms indicative of what the children of each mental age are capable of doing. Each individual is then assigned daily lessons and duties according to the norm for his mental age. The work has not yet been carried far enough to fix final norms, but the very introduction of the principle of seeking such adaptation has had a most wonderful effect on the institution. Thus, a boy who has had eighteen birthdays and is of normal size enters the institution as a helpless dependent; he is tested under the direction of the psychologist and is found to be mentally of the calibre of an eight-year-old and is therefore classified with the group of that age. The norm shows that a lad of eighteen but mentally developed only to the age of eight, and with slight, if any, prospects for further development, can not read, nor write nor figure serviceably, but he can feed himself, make his bed, fold his napkin, keep himself clean, help a crippled brother, lead a horse, carry water, pitch hay, hoe the garden, toss a ball, do small errands, etc. (the items specified are fictitious). He cares little for play, but is an automaton, glad and effective in repeating the same simple tasks. His program for each day is therefore mapped out according to the norm showing the upper limit of what he can do. The result is that he is busy all day, industrious and useful and therefore happy and good. The secret of it all is that he has *found his level* and *is allowed to live on it*. His ambition is realized and he is proud and grateful for what he can do. He is an illustration of scientific adjustment. Compare this boy with his equal in the ordinary institution for the feeble-minded where he is detained as an inmate out of adjustment, irritated by the things he can not do. Adjustment transforms an institution of detention into a house of happiness and usefulness; and, instead of being expensive, it makes the institution more nearly self-supporting, for every individual is assigned to the place of his greatest efficiency.

In conclusion, let me sum up this all too brief appeal. Applied psychology can not always live by the crumbs that fall from the professor's table, nor can it get its full vitality from the non-psychological professions. It must be fostered by the specialist who devotes himself to it for its own sake. It must recognize itself, its own peculiar technique, its vastly varied fields, its diversities, its stupendous difficulties, its essential limitations, and withal its promise and worth.

THE WORK OF THE CHEMIST IN CONSERVATION[1]

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AMONG business firms it is the custom at regular intervals to stop and take an inventory of the stock on hand, to set opposite one another the income and expenses of the past, and to strike a balance which shall show the condition of the institution. Within the past few years this country has been engaged in such a stock-taking of its natural resources and we have reports from various quarters as to its condition, showing that its affairs, in respect to these resources, have been recklessly managed and that without a change in its methods it is rapidly traveling toward insolvency.

We learn that the end of our mineral deposits is in sight; that the United States produces every five years as much iron as the whole world in the 350 years previous to 1850; that in 1907 over 100 times as much steel was made as in 1874; that our coal, which was millions of years in formation, is being dissipated in hundreds, and even in tens. We are told that the next generation may see the end of our anthracite coal and that, while the bituminous may last ten times as long, the limit of the amount available can be closely calculated.

Recent developments in the use of petroleum as a fuel have been rapid. This is also true of its derivative, gasoline, which, up to the present time, is the only satisfactory fuel to furnish energy for aviation and one of the most successful in boats, automobile motors and for many other purposes. Such an enormous demand has been created that the United States Geological Survey predicts that the known supplies of petroleum can not last more than about fifty years. The closely related natural gas is being used at an alarming rate and no scientist claims that its production approaches the rate of its consumption. Charcoal as a source of heat is practically negligible. Our forests are disappearing—half a million acres annually for railroad ties; fifteen acres for a single issue of a metropolitan newspaper; an estimated total consumption of wood amounting to one hundred thousand million board feet.

This depletion of our resources is perhaps a necessary accompaniment to the demands of an increasing national prosperity; but the case has an even darker side. The waste of material is terrific. The Anthracite Coal Waste Commission reported in 1893 that "for every ton pro-

[1] An address delivered to the Society of Sigma Xi, State University of Iowa.

duced one and one half tons were lost." That is due to our carelessness: to our limited knowledge is due the waste of over ninety per cent. of the energy of the coal burned under our steam boilers but not given out by the connected engine.

In the preparation of blast-furnace coke from coal by far the greater part of the by-products are not saved. Thus Bogart states that in 1907 62,000,000 tons of coal were coked, but only 14 per cent. in such a way as to recover the by-products; that by this process there were wasted 148 billion cubic feet of gas worth 22 million dollars, 450,000 tons of ammonium sulphate of as great value and tar to the value of nine million dollars, and that the gases lost annually in the coke industry have a calorific power equal to four billion kilowatts, or three billion horse power. As to natural gas, the United States Geological Survey accepts the judgment of State Geologist White, of West Virginia, that not less than one billion feet are wasted daily. "This," he says, "equals the annual consumption of natural gas reported for 1907. This waste should furnish light for half the urban population of the United States."

Of our forests thousands of acres are destroyed each year by fire and, in addition, a large part of the cut is left to rot as stumps, tops and branches, only the best part of the trees being used. The story of the soil has been similar; we have raised crop after crop from it, robbing it of the elements which the plant must have for the building of its tissues. Of all except three of these the average soil has a sufficiency, but potassium, phosphoric acid and combined nitrogen are frequently deficient. Inasmuch as plants can not thrive unless all their needs are provided for, it follows that these must be supplied if they are in any degree lacking. At present we are drawing heavily upon our resources of all three. Potassium, in early days derived from wood ashes, is now being taken from the immense deposits at Stassfurt; but it is a well-known fact that recently the German government has taken measures to largely prevent the exportation of their output. Phosphoric acid has been furnished by our mineral phosphates, which have been recklessly drawn upon for domestic use as well as for exportation until the supply is sadly impaired.

Some species of plants can utilize the free nitrogen of the atmosphere, but most of them can assimilate this necessary element only when it has been previously combined with others in such compounds as saltpeter, ammonium salts or organic matters. One of these, Peruvian guano, has already disappeared. The great deposits of sodium nitrate —Chile saltpeter—on the west coast of South America are being fast removed. Nearly one hundred million dollars' worth are shipped in a year and thirty to forty years will probably see the last of this supply. No other known deposits can replace it. The ammonium salts from

our gas-works are totally inadequate to the demand. These are but typical wastes.

Our improvidence is shown in other fields. Our average mortality is high, exceptionally so among infants. Take an example near home. In the month of July last 245 infants under one year of age died in the state of Iowa, 109 of cholera infantum. Last August there were in the same state 1,785 deaths: of these 472 (more than one fourth) were under 5 years of age; of these 350 (about one fifth of the total) were under one year. Of the infants 291 died of cholera infantum, a disease difficult to cure but nevertheless recognized by sanitarians as entirely preventable. Illness is frequent in the whole country. According to the Report of the Committee of One Hundred on National Vitality, three million people in the United States are at all times seriously ill, half a million of tuberculosis. Drugs and stimulants are used excessively; food, improper in quantity, or in the kind and proportions of its nutrients, is often the rule, thus lowering human vitality and decreasing efficiency.

The food and water that we eat and drink, the atmosphere that we breathe, are deteriorating. The mere mention of food adulterations will suffice. Our industrial waste products are poured into our streams; our sewage and garbage, for the most part, directly or indirectly, share the same fate. The quality of our inland waters is therefore steadily deteriorating. We can depend less and less upon our rivers, springs and shallow wells for domestic and city water supplies. Even the industries where a pure or an impure water represents the difference between a high grade and an unsatisfactory product, are seriously hampered by being limited to a badly polluted water for steam making and other purposes. Many of our fresh-water fishes have become locally exterminated, particularly in the eastern manufacturing sections, and many a smiling river, and pleasant stream, have become converted into mere open sewers which carry away, more or less efficiently, unidentifiable contaminations.

The pollution of the atmosphere has increased with civilization. Not only are the gases from our heating and power plants blown into the air with half-consumed matters in the shape of soot and cinders, but from chemical industries acid gases and other noxious products are allowed to escape and to drift whither they will. The sulphur dioxide from the smelters destroys vegetation, including forests, for miles around. When these are gone denudation commences and rapidly progresses until the region appears a veritable desert. Arsenious oxide is usually found in such gases, and not only aids in the destruction of the vegetable world, but, over great areas, leaves the marks of acute or chronic poisoning upon the animals that graze within the district and upon human beings that breathe the air. In comparison with these

effects the pecuniary loss from materials lost in smelter smoke may seem unimportant, but measured in dollars and cents it is considerable. Take, for example, bismuth for which there is a steady commercial demand. According to a conservative estimate, in the smoke of the great Washoe smelter at Anaconda there are lost 880 pounds daily. Considering that 10,000 pounds represents the annual American production, it is evident that eleven days would see a waste equal to a year's output of our mines.

Such is the black picture that is painted for us. What of the future? Must the human race abandon a large part of the earth's surface, which it has conquered, because of insufficient means to maintain its bodily warmth? Or must it become a race of troglodytes, dragging out its degenerate existence in the caverns of the earth? Will our agriculture deteriorate, little by little, until the scanty crops from an impoverished soil hardly support a degraded people? Or will the air and water become so polluted that the race, if it be not so modified as to meet the new conditions, must become extinct? Is our boasted civilization only a myth, the growth of which leads inevitably to destruction?

Can our natural resources be so conserved as to supply the immediate and the future needs of the nation? Of what avail is our science which we have so often exalted, and how far can it help us in the solution of this perplexing problem?

We must see that the only conservation which can avail is conservation with utilization, a concept which was clearly set forth by President Taft in his recent St. Paul address:

> The idea should not be allowed to prevail that conservation is the tying up of the natural resources of the government or indefinite withholding from use. Real conservation involves wise, non-wasteful use in the present generation, with every possible means of preservation for succeeding generations.

As we face the problem can we say, as did Patrick Henry, of political questions, "I know of no way of judging of the present but by the past," and, judging by the past, has our science achieved anything which should give us unshakable confidence in its power to meet this crisis? Let us look back into the not too distant past of science for the answer. It comes from many parts of her realm. I may perhaps be pardoned if I draw most of my illustrations from that field with which I am most familiar.

While science has met the demands of the time as they have arisen she does not, as a rule, much anticipate them. It was only after years of extensive working of the saltpeter deposits of South America that in 1889 Sir William Crookes brought home to the civilized world the true significance of the situation—that the supply of combined nitrogen was approaching exhaustion; that this meant the cessation of plant and animal life, and that to avert such a calamity new sources of these compounds must be sought. At the time one means of relief was suggested

by him—the fixation of atmospheric nitrogen, that is, the conversion of this gas, inert and non-utilizable, into nitrogen compounds which could be assimilated by the plant and from this pass to the animal for the building and repair of its tissues. There was the problem for the chemical engineer and the chemical engineer has worked out its solution. The principle employed is to burn the nitrogen of the atmosphere through the agency of the oxygen, by passing the air through a flaming electric discharge. Although this sounds simple, the commercial operation was most complex. The shape and size of the electrodes and their container, the correlation of quantity and intensity of the electric current, of the temperature and volume of air, all demanded patient care as well as expert knowledge. Not only must oxidation be controllable, but the costs must be studied and reduced until a commercial success was assured. The first companies did not succeed and went into bankruptcy, but now, using the power of the mountain streams of Norway and the Tyrol, the nitrogen of the air yields its freedom and leaves the factory as calcium nitrate and sodium nitrate, which go to be mixed with the other constituents of artificial plant foods, or as nitric acid, which is used in so many technical processes. There are now in operation chemical plants which can place upon the world's markets annually 100,000 tons of pure calcium nitrate thus obtained through the use of atmospheric nitrogen.

While one group of chemists were following this solution of the nitrogen problem others had taken another line, influenced partly by a different motive. This was the development and an outgrowth of the calcium carbide industry. After the French chemist, Moissan's, brilliant work upon the production of carbides by the electric furnace the field was occupied commercially and in many places where cheap water-power could be obtained—Niagara Falls, Norway, Switzerland and others—calcium carbide was made for acetylene lighting. The annual output is about 200,000 tons. But this is more than is called for in the preparation of acetylene. There must be some way of using the excess, and the services of the chemist were in demand.

When free nitrogen is led over calcium carbide at the proper temperature it is absorbed, forming calcium cyanamide. The latter is decomposable by steam, its nitrogen being evolved as ammonia, a valuable plant food. There is the same decomposition when the calcium cyanamide is placed in the ground; the decomposition is then so slow that the ammonia does not escape into the air, but is held in the soil until it is utilized by the plant.

Thus the chemist has built another bridge over the gulf between free and combined nitrogen, cyanamide, or "nitrolime," acting as the middle pier. Nearly 200,000 tons can be annually furnished by the works now built or under construction.

Thus chemists and chemical engineers have answered the demand of the hour. With the boundless atmospheric nitrogen and with water power, the development of which has scarcely begun, man need never fear an insufficient nitrogenous food supply.

We are inclined to lament because of the extent to which some of our limited natural resources, such as iron, are being drawn upon. But if we compare the condition of the people of the United States now with that at the time when these resources were comparatively untouched we must admit that their use has added immensely to human comfort and progress, and that this increased comfort could have been gained in no other manner. In addition we must consider that, although much material is being used, the processes of putting it upon the market are gaining immensely in economy of operation through the studies of scientific men, and that much that we were in the habit of discarding is now used repeatedly. So that the total amounts taken from their terrestrial storehouses does not fairly represent the loss to humanity.

For instance, since the time of Tubal Cain until about the end of the fifteenth century iron ores were reduced in a crude forge where the yield ran from 100 to 300 pounds per charge—far less than a ton per day. Compare the continuous process of the modern blast-furnace producing 75,000 or more tons annually and think how many conveniences we should be deprived of if we were still limited to the primitive methods. Compare also the price per ton of pig iron from the old and the present processes and no doubt will remain that wastefulness is relatively immensely less in the iron industry now than then. Nor is iron once used discarded, but it is worked over into new forms and employed for other purposes.

Previous to 1856 the only means of producing steel was to laboriously remove the carbon from the pig iron in the puddling furnace, roll the iron into bars, slowly add the requisite carbon again by heating the two together for days, and melting or hammering to get a homogeneous product. But in 1856 Henry Bessemer announced his process for making steel from pig iron in one operation, a process so simple that we please ourselves by thinking that we might have invented it if it had not previously been done. Bessemer found it necessary only to burn out from the molten crude iron the impurities, carbon and silicon, by a blast of air forced into the bottom of his crucible, just as we stimulate the burning of fuel in our fireplaces by the use of a bellows. No fuel was added as the heat from the burning impurities was adequate to keep the mass melted until the change was complete. To the purified iron thus obtained he added the requisite amount of carbon and, in half an hour, had a dozen tons of steel. The price of steel rails before and after the Bessemer process came into vogue is a testimony not only to the knowledge of the metallurgist, but to the saving in time, labor

and fuel, a real conservation of resources. More recently as high grade ores suitable for the Bessemer process are becoming scarcer the metallurgist has added to his equipment the open-hearth furnace in which ores of a much inferior quality can be smelted.

The history of aluminum offers an even more striking illustration. For many years after it was isolated by Wöhler from its fused halogen compounds through the addition of metallic potassium it was somewhat of a chemical curiosity. Owing to the high cost of potassium the lowest price at which it could be sold was several dollars an ounce. It could not be bought in any large quantity. I distinctly remember the pride with which one of my earliest teachers of chemistry was wont to exhibit to his classes a piece of aluminum about as large as his finger, and with what delight he would tell of Wöhler's custom, in saying good-bye to his newly made doctors of philosophy, of bestowing upon those with whom he was particularly pleased a piece of the precious metal, this being such a fragment. That was not many years ago; yet in 1907 there were produced in this country 17,000,000 pounds which sold for about five million dollars—less than 30 cents a pound. And this was the answer of chemists and metallurgists to the demand for a light, permanent metal at moderate cost. What the future of aluminum may be we do not know. But being in abundance, the second of the solid elements and twice as large in amount as iron, its compounds can not possibly be exhausted.

Alizarin, which is one of the important vegetable dyes, was formerly obtained from madder, the root of a plant growing abundantly in the south of France and some other Mediterranean countries. The demand for it increased until thousands of acres were given over to the cultivation of the *Rubia tinctorum*. But in 1868 two chemists, Graebe and Liebermann, after long study, succeeded in preparing alizarin synthetically from anthraquinon, a coal-tar derivative. It drove from the market the natural alizarin. There was an outcry from those who had cultivated the crude material that their means of livelihood had been destroyed. But thenceforward the fertile fields which had been devoted to its growth were used to furnish foodstuffs to the country. A waste substance had been used and the old energy turned into better channels.

A similar history is that of indigo, one of the standard dyestuffs of our grandmothers—a product of the indigo plant. Adolf von Baeyer, chemist, of Munich, in 1870 overcame the difficulties of its synthetic formation and, from coal-tar again, by complicated methods prepared this substance, one of the most stable of our dyes. Other chemists have simplified the process until now it is formed in the factory, a rival of that from the field, and thus large tracts of land are released for other forms of agriculture.

If the past achievements of science give us hope that it can stay the drain upon our resources, we can gain encouragement by examining its present activities.

While doubtless much fuel has been wasted it is now being used much more economically than formerly. There is a tendency to centralize the evolution of heat and other forms of energy produced from burning coal. A large proportion of our coal is used in locomotives for the purpose of hauling more coal to the place of consumption. This can be saved by carrying the energy from the coal fields as electricity or gas. Even the conversion of coal into producer gas at the place it is used is a great advantage. The lowest grades of coal are employed, such as lignite, slack and culm, and the gas gives several times as much energy under a boiler as would the coal from which it is made. Again, our culm piles, the accumulations of years, are being moulded at slight expense into briquettes which are in many respects superior to coal as a fuel.

As a substitute for our vanishing gasoline we are looking toward alcohol. Although at present it can not compete in price, new sources are being sought by the chemist and it will undoubtedly become cheaper. Not only can the crude material for its manufacture be obtained from the grains but working processes have been announced, starting from the cellulose of sawdust and peat.

I need only refer to the value of our water power. It has been estimated that the United States has about 40 million horse power which is now available and four times this which can be developed. To get an equal amount of energy from our steam plants would require over 3,000 million tons of coal. Or, to state it in another way, by developing this water power, now not utilized, over three thousand million tons of coal can be saved—about four times our annual consumption.

With a possibility of the disappearance of available petroleum and even of coal, substitutes for these have been ardently sought in recent years or, if not complete substitutes, attempts are being made to find something which will decrease their excessive use.

As we all know, the luminosity of illuminating gas is due to minute particles of carbon which are heated to incandescence. A substitution of other solid materials in the hotter, though non-luminous, flame of the Bunsen burner—lime, platinum and zirconium—met with failures. Then came a German chemist, Auer von Welsbach, and discovered, through extensive investigations with the oxides of the rare earths, that while neither thorium nor cerium oxides were highly luminous, if one per cent. of cerium oxide is added to thorium oxide the product glows at high temperatures with great intensity. The gas mantle and incandescent light were the result, and with them a far greater degree of illumination, with the use of a fraction of the gas formerly used.

We are all acquainted with the results of the labors of science in the fields of acetylene and electric lighting, where energy is furnished by water power or where cheap coal can be burned miles away from the dazzling lights. Every city has its object lesson. Only one instance will be spoken of.

The deficiencies of the carbon-filament incandescent electric light bulb are known to all of us—its reddish light, its decrease in brilliancy with use, its comparatively short life and rather low efficiency. Most of us can testify to the superiority of the tungsten bulb, one of the latest productions of the chemist and electrician—its white light, its long life with but slightly lessened intensity, the comparatively low cost of the light per candle power.

From a relatively slightly known substance—material for the mineralogist's collection—the use of tungsten has rapidly increased. Forty-six tons of its ore were mined in the United States in 1900; in 1907, 1,640 tons; truly, in comparison with iron, copper and lead, an insignificant amount. But when we remember that one pound will make thousands of electric-light filaments we can comprehend that revolutionary results may follow. The ore is widely distributed in the Rocky Mountains, as far north as Alaska, and no prophecy can be made as to when it may become exhausted.

Tungsten has many other uses possibly less known to you; among them, as a material for small crucibles to be used in the electric furnace, and as a modifier of the properties of steel, the latter probably the most valuable. Tool steel containing tungsten holds its temper at high temperatures. Tools with a tungsten content of 16 per cent. to 20 per cent. can be used with the lathe running at such a speed that the chips are blued from the heat yet the temper of the tool is not affected. That is, in consequence of the high speed, about five times as much work can be accomplished as when high carbon steels are used, one man's labor being thus multiplied by five. Here again the metallurgical chemist has shown himself equal to the demand upon him, a demand for a new means of decreasing the drain upon a part of our resources.

What about the forests? Personally I have no fear. Aside from the methods of scientific forestry, which must necessarily come, other forces are acting. Although the chemist uses forest products as a source of supply, he need not be feared. He can utilize the waste wood —the stumps, the chips, the branches, the sawdust, material fit for nothing else. And he is daily perfecting chemical products to take the place of wood. Cement is one of these; of this the amount is increasing and the cost diminishing. In 1908 we made in the United States 51,072,612 barrels of Portland cement at a cost of $43,547,679, an increase over the preceding year of over two and a quarter million barrels with a decrease in cost of more than ten million dollars. In 1909 some-

what over sixty-two and one half million barrels were manufactured at about 80 cents per barrel as compared with 85 cents in 1908.

We are so accustomed to our wooden houses that we dread to have to give them up even when we know that in many other countries they are almost unknown. We are unmindful of Ruskin's dictum, "I would have our ordinary houses built to last," as well as, "built to be lovely, as rich and full of pleasantness as may be within and without." We are regardless of the thought that, instead of erecting a structure which can endure 50 to 100 years, it may be better to build for 500 to 1,000 years or more.

In other ways the chemist is conserving the forests; by guarding against one of the greatest dangers to our wooden edifices—fire—through fire-proofing processes, and against their bacterial foes, which cause decay, through wood preservatives. As to stopping the journey of our forests to the paper-mill, it appears not to be the time for that yet, but chemists are finding ways of replacing wood fiber in paper by others, notably those of grasses. Even if it should prove beyond the skill of the chemist and engineer to continue our present output of paper from the dwindling wood supply and should most of our Sunday papers be forced to curtail their issues, who will see in that any dire calamity?

Cement is frequently used to preserve not only wood, but in many places iron, and so conserves this material. Where more strength is required than concrete possesses, iron surrounded by cement has been found to last indefinitely. The process of reducing the crude iron from the ores has been steadily improved so that now, through such means as using the heat formerly wasted from the blast furnace to heat the air of the blast, to make steam and to dry the air before it is blown into the furnace, but a fraction of the coal is required that was formerly necessary. Similar savings have been made in other parts of the metallurgical field; for instance, in the recovery of gold and silver during the treatment of copper and lead ores, several million dollars worth being thus annually obtained, and this by the old methods would have been for the most part wasted.

The loss of by-products in the manufacture of coke has been referred to; but closer chemical supervision is rapidly reducing this. In 1905 over thirty-seven million tons of coal were coked in the United States, but less than 9 per cent. in ovens where these by-products were preserved. Two years later the amount coked in by-product ovens had increased about one half.

Foreign chemical engineers are setting us a praiseworthy example. In Gelsenkirchen, Germany, the coke ovens furnish illuminating gas to surrounding cities and villages at 23 cents per 1,000 cubic feet. Each ton of coal yields three to three and one half gallons of benzene, a valuable substitute for gasoline as a producer of heat and energy. From the

recovered tar are separated naphthalene, toluene and anthracene from which are derived the brilliant coal-tar colors and many synthetic medicinal compounds, also disinfectants and preservatives like carbolic and benzoic acids. In Germany the coal coked so that the by-products could be recovered was 30 per cent. in 1900; 82 per cent. in 1909.

Our chemists are devising means to prevent the contamination of the atmosphere by industrial wastes. Witness the Sulphur, Copper and Iron Company at Ducktown, Tenn., whose blast furnace gases contain a high percentage of sulphur dioxide because of the abundance of sulphur in the ores. Instead of, as formerly, allowing this to escape to poison the surrounding vegetation it is caught and converted into sulphuric acid. One hundred and sixty tons are produced daily, of high purity; a waste product has been converted into an article of commerce for which there is a constant demand.

In agriculture the general outlook is highly encouraging. True, much time will pass before the agricultural chemist is estimated at his real value, but even now the farmer is making use of his assistance and asking for his aid with increasing frequency. He is learning that the old "rule-of-thumb" methods are unprofitable, and when he is convinced that science can more abundantly fill his purse, the end that we desire is in sight. It is within the remembrance of most of us what a change has taken place in Iowa, within the past fifteen or twenty years with respect to fertilizers—the putting back into the bosom of mother nature the nourishing elements of which our crops have deprived her. Fortunately our farms are still exceptionally fertile and by scientific treatment we of Iowa may not be reduced to that dependence upon artificial plant food which is so painfully noticeable in New England and other eastern states. But our pride in our soil should not lead us to overlook our imperfections. When we know that our average wheat crop is, for the country, only twelve to fifteen bushels to the acre, that of England, the Netherlands and Denmark over twice that and that on some of our experimental farms it runs up to seventy to eighty bushels, it should make us pause for serious reflection. On the other hand, if, as we are told, the average crop of the Romans was but four to five bushels we can take courage and strive for better results.

I have spoken of new means of getting nitrogen, one of the three plant nutrients most apt to be deficient. A second, potassium, occurs abundantly in feldspars in a comparatively insoluble form. Recent experiments by chemists, however, indicate that through very fine grinding the door is unlocked which will set it free in a form which the plant can assimilate. For the third nutrient, phosphoric acid, we must probably depend upon re-using that taken up by the plant or upon undeveloped deposits. Happily, we have such ones. Announcement has just been made by geologists of large phosphate beds in several of our western

states. Knowing how nearly we have approached phosphate poverty we can take measures to more properly protect them.

With these materials, with the systematic study which is being carried on in government laboratories, in experiment stations, in agricultural colleges and universities of the chemistry of the soil and of the food and metabolism of plants, with the industry of the fertilizer chemists, and with the awakening of the farmer to the needs of such knowledge, we can hopefully expect a bountiful food supply for the world's table.

The aid of science is noteworthy in increasing human vitality,—one of the principal factors in national efficiency, and a form of conservation. In the sixteenth century the average length of human life is estimated as being between 18 and 20 years; to-day it is between 38 and 40 years. Modern hygiene is markedly lowering mortality and lessening illness. Compare the former death rate of Havana, 50 to 100 per 1,000, with the present one which is but little more than that of our northern cities. Note the disappearance of yellow fever and cholera from the Isthmus of Panama and the fall of the death rate to one third of that of the French administration. Known to everybody is the successful fight which is being waged to decrease the ravages of small-pox, tuberculosis, diphtheria, meningitis and the hook-worm.

The food of the nation is being studied as never before by hundreds of chemists; the actual needs of the body are being determined, the kinds and amounts of food adapted to particular conditions are learned, dangerous and adulterated foods are proscribed. Through the studies of milk and children's foods by physiological chemists the mortality of infants has been greatly diminished. In all these conflicts against disease the chemists are in the front of the battle. A strenuous campaign of education must be carried on, but already the light begins to shine into the dark places.

In this broad field of conservation where the opportunities for labor are so great how are we, as educators, doing our part? Are we merely applying our scientific knowledge, or are we also training others for service—the young people of this university?

Regardless of current discussions as to woman's proper place in the social fabric, it is certain that society has caused her to specialize as the conserver of the home. Her position may be modified in the future, but it will be long years before she abdicates this regal station. I do not mean that she should remain a household drudge, confined to the walls of the kitchen, nor do I intimate that all women can, or care to, be so distinguished. But Woman—*das Ewig-Weibliche*—is destined long to preside, the goddess of the family, as in the days of Solomon, the Wise, for, as then,

Her price is far above rubies.
Her children arise up and call her blessed;
Her husband also, and he praiseth her.

In common with other large universities we are doing our best for the young men, preparing them for the professions or the business to which they will be called—physicians, lawyers, dentists, engineers, chemists, accountants—fitting them to aid in the conservation of material resources, of liberty and of life.

When we are asked regarding our stewardship of the young women a discreet silence may be the safest reply. We are giving them disciplinary studies, a general education in subjects interesting alike to man or woman, an opportunity to develop the social instincts, to gain by association with educated people, and to become more at ease in society. But we look in vain for a careful training in the field where woman should be supreme, an opportunity for any detailed study of chemistry with the related sections of physics, bacteriology and physiology, as applied to food and diet, disinfection and disease, particularly diseases of children, general prophylaxis, sanitary construction, the disposal of wastes, and the manifold other problems of the home. As homekeeper much of the financial success of the average family will depend upon her. Where is she getting the instruction? Most men are only indirectly interested in such problems and therefore if woman can not, or will not, solve them they will be unsuccessfully met. It is true that most of them are merely applications of scientific principles, and that somewhere in the university these principles are taught. Yet nowhere are they correlated to make a systematic course for this large proportion of our students. The men of the University of Iowa may make good husbands, but, as a rule, they will not be able dieticians; the women may make the best of wives but, in that case, the university can claim but a small part of the credit for it. The University of Iowa is missing its great opportunity.

In all this I am not pleading for the special training of teachers and experts; only for aid in the conservation which shall supply our needs, through the symmetrical development of our students and their best preparation for their life-work.

I have spoken of a few of the means used by science to conserve our resources, but they are typical of hundreds of others carried on all over the world by thousands of men with chemical training and working by scientific methods. From this present activity we can look ahead and predict some of the tasks next to be accomplished. Were the time sufficient, it would be interesting to discuss them—the probability of the synthetic production in the laboratory of many of our foods now only formed by the slow processes of nature; a system of intensive agriculture whereby our crops will be increased many fold;

more perfect means of storage and preservation of foods so that we may at any time avail ourselves of them in their natural freshness; the almost complete control of disease; the utilization of the hitherto uncontrolled energy of the sun through the collection of its heat; and the practical use of the force of the tides. These, however, we shall have to pass by for the present. Nor shall I dwell upon the possibilities of that almost unknown force locked up in the atom and revealing itself as radioactivity, far superior to any other known power. Whether we shall ever be able to liberate and control it we can not even surmise.

In all this I have emphasized the materialistic side, the gaining of dollars and cents, of all that can contribute to comfort and ease, and all to result from applied science. Do not, therefore, regard me as belittling that other aspect—the pursuit of knowledge for its own sake, the irrepressible striving to raise one's self through earnest effort toward the level of the Omniscient, the feeling of Paracelsus in his laboratory,

> I still must hoard and heap and class all truths
> With one ulterior purpose: I must know!
> for night is come
> And I betake myself to study again,
> Till patient searchings after hidden lore
> Half wring some bright truth from its prison; my frame
> Trembles, my forehead's veins swell out, my hair
> Tingles for triumph. Slow and sure the morn
> Shall break on my pent room and dwindling lamp
> And furnace dead, and scattered earths and ores;
> When, with a failing heart and throbbing brow,
> I must review my captured truth, sum up
> Its value, trace what end to what begins,
> Its present power with eventual bearings,
> Latent affinities, the view it opens,
> And its full length in perfecting my scheme.

For our hearts still harmonize with the outcry of the alchemist,

> I shall arrive! what time, what circuit first,
> I ask not: but unless God send his hail
> Or blinding fireballs, sleet or stifling snow,
> In some time, his good time, I shall arrive.
> He guides me and the bird. In his good time!

And it is through this patient and persistent toil that in the future, as in the past, man will triumph over the forces of nature,

> For these things tend still upward, progress is
> The law of life, man is not Man as yet. . . .
> But when full roused, each giant-limb awake,
> Each sinew strung, the great heart pulsing fast,
> He shall start up and stand on his own earth,
> Then shall his long triumphant march begin,
> Thence shall his being date—thus wholly roused,
> What he achieves shall be set down to him.

THE PROGRESS OF SCIENCE

ABOUT DISMISSING PROFESSORS

THE president of one of the leading universities in the east and the president of one of the leading state universities have recently expressed opinions in regard to the tenure of office of the university professor which deserve careful attention. In his annual report to the trustees, President Butler, of Columbia University, writes:

A teacher or investigator who offends against common morality has destroyed his academic usefulness, whatever may be his intellectual attainments. A teacher who offends against the plain dictates of common sense is in like situation. A teacher who can not give to the institution which maintains him common loyalty and that kind of service which loyalty implies, ought not to be retained through fear of clamor or of criticism. Then, too, a university teacher owes a decent respect to the opinions of mankind.

In the issue of *Science* for February 17, President Van Hise, of the University of Wisconsin, says:

. . . the instructional force of a university, both young and old, must be efficient. Whether or not a man is retained in a faculty should depend upon his capacity to meet his duty to the institution. There is no possible excuse for retaining in the staff of a university an inefficient man.

It is certainly desirable that professors should be moral, efficient, sensible and loyal; they should have even other qualifications than those which they share with domestic servants. But it is a far cry from this to the claim that the president should dismiss professors whenever they seem to him to lack these traits. Such a claim obviously traverses academic traditions. Professors receive their appointments at the average age of forty years. If a mistake is made, it is the fault of those who appoint, and they should accept the responsibility. Professors who prove to be less competent in the management of large classes in the undergraduate college and in the professional schools should be relieved from them, but it is more economical to pay an occasional professor his salary without full return, than to place the whole university under the law of supply and demand. By the nature of things, some professors are less competent than the average of them all, and any university could temporarily raise the average by replacing ten per cent. of the faculty. But it would be the old story of killing the hen that lays the golden eggs.

President Van Hise says:

The question now arises as to what should be done in the case of a man of professorial rank, whether full, associate or assistant, who is not efficient. Not infrequently papers with reference to this subject appear to assume that universities exist for the instructional force; that the main thing is to give that force a comfortable and happy time, an opportunity for a somewhat easy existence as a teacher, leisure for browsing through literature, and long vacations.

A scientific man should give references to his authorities; but President Van Hise apparently thinks that professors in general hold such opinions and would like to form a privileged class. According to President Butler they do form such a class. He writes in his report:

The happenings of the past decade [that is since he became president] have made the lot of a member of the permanent teaching staff of Columbia University one that is indeed fortunate. . . . It may be that there is some other career that is equally fortunate, but if so, the fact does not appear to obtrude itself upon the public attention.

President Butler, however, seems to realize that professors do not share his opinion as to their happy lot, for

in an editorial article in the last *Educational Review* he writes:

Truly the academic animal is a queer beast. If he can not have something at which to growl and snarl, he will growl and snarl at nothing at all.

In the *Educational Review* for October last he quotes from *The Nation* the following:

There is a fine opening for a new institution to show what a college can be wherein the personal domination by the president is abandoned, and in its stead we have a company of gentlemen and scholars working together, with the president simply as the efficient center of inspiration and cooperation.

and with some inconsistency remarks:

Concerning this statement two things may be said with a considerable amount of emphasis. The first is that the condition described in the last four lines is precisely what is to be found at every American college and university that is worthy of the name, and that no evidence to the contrary has ever been produced by anybody. The second is that, while the attempt to create a contrary impression may be originally due to ignorance, when persisted in it can only be attributed to malice.

Permanent tenure of office for the professor is not such a unique state of privilege as President Van Hise imagines. A president's wife has permanent tenure of office; he can not dismiss her because he regards her as inefficient or because he prefers another woman. In the army and navy, in the highest courts, to a certain extent in the civil service of every country, there is permanence of office. Indeed it is nowhere completely disregarded; service is always a valid claim for continued employment. Perhaps one wife in fifty is divorced by the courts, one army officer in a hundred court-marshalled, one judge in a thousand impeached; but such actions are taken after definite charges and opportunity for defence.

Permanent tenure of office is intended to improve the service, not to demoralize it. It is attached to honorable offices, where public spirit and self-sacrifice are demanded, and the wages do not measure the performance. In Germany, France and Great Britain the permanence of tenure has given dignity and honor to the university chair, attracting to it the ablest men and setting them free to do their best work. In this country the better the institution, the more permanent has been the tenure of office. Up to the time of the writing of President Butler's report only one professor had ever been dismissed from Columbia University, and then it was for entering the confederate army.

It is possible to adduce arguments for the introduction of the competitive system into the university. Thus President Butler holds that it is undesirable to pay equal salaries. He says:

In my judgment such a policy would fill the university with mediocrities and render it impossible to make that special provision for distinction and for genius which the trustees ought always to be able to make.

But it appears that the general course of social evolution is not towards competition. In the university it would probably be adverse to the finer traits of scholarship and character, most of all when, as under our present system, the competition would be for the favor of presidents and trustees. The president may assume superhuman responsibilities, but he is after all human in his limitations. He may regard common sense as agreement with him, common loyalty as subservience to him, respect for the opinions of mankind as deference to that small portion of mankind which has money to give.

If there is to be competition in order to retain university chairs, then the university must be prepared to forego able men or to compete with other professions in the rewards it gives. It must offer prizes commensurate with those of engineering, medicine and law, namely, salaries as large as a hundred thousand dollars a year. It is further true that under these circumstances a man must be judged by his peers.

There are doubtless advantages in a system of severe competition for large prizes under honorable conditions, as well as in permanent tenure of office with small salaries and a free life; but confusion and harm result from running with the hare and hunting with the hounds. A university which dismisses professors when the president thinks that they are inefficient or lack common sense is parasitic on the great academic traditions of the past and of other nations. A single university which acts in this way will in the end obtain a faculty consisting of a few adventurers, a few sycophants and a crowd of mediocrities. If all universities adopt such a policy, while retaining their present meager salaries and systems of autocratic control, then able men will not embark on such rotten ships. They will carry forward scientific work in connection with industry and will attract as apprentices those competent to learn the ways of research.

THE GRADUATE COLLEGE OF PRINCETON UNIVERSITY

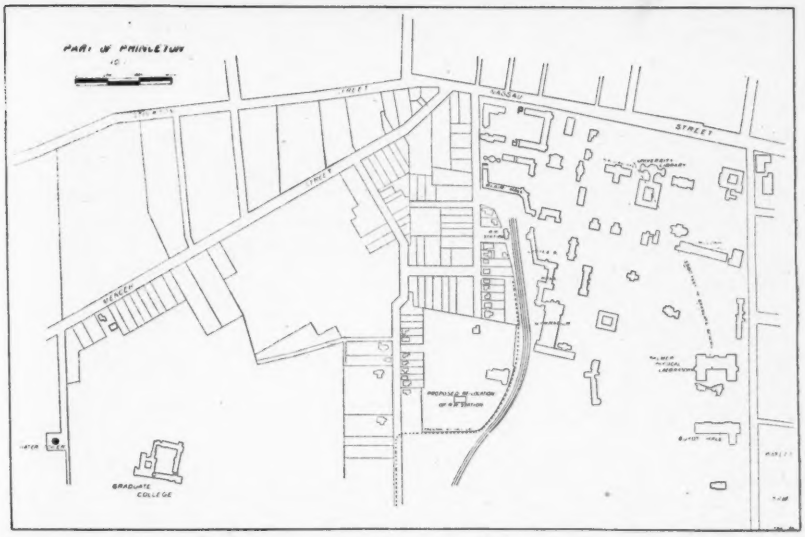
PRINCETON UNIVERSITY has now no president and could get on admirably without one. It is true that the professors at Princeton who disagreed with the president and opposed his policies were not dismissed for lack of common sense and common loyalty. On the contrary, they won victories in a fair field where each side contended for principles. It is also true that at Princeton one professor has been able, first with and then without the favor of the administration, to carry out the plans which he formed. But the question arises whether Princeton could not to advantage place the control of its policies formally in the hands of its faculties.

If the new graduate college should, like the colleges of the English universities on which it is confessedly modelled, be placed in charge of its fellows and professors, letting them be responsible both for appointments and for finances, then there could and would be gathered there a group of scholars such as has not been seen in this country since the early days of the Johns Hopkins University. There are but few of the younger men on whom the future of scholarship and research depends who would not gladly go to such a college, whether as teachers or as students.

The graduate college of which Professor West has dreamed, for which he has worked and which he has now made an accomplished fact is described by him in the last number of *The Century Magazine*, with special reference to the ideal of the scholar's life. Thanks to the bequest of Mrs. Swan, to the liberal gift of Mr. Proctor followed by gifts from other alumni, to the subscriptions to a memorial of Grover Cleveland, who was the first chairman of the committee of the graduate college, and to the large endowment left by Mr. Wyman, the graduate college has resources amounting to between three and four million dollars. Of this sum about six hundred thousand dollars will be spent on the buildings, including the Cleveland memorial tower, the Proctor dining hall and the Thomson residential court. The greater part of Mr. Proctor's gift and practically the whole of the Wyman bequest will be devoted to the endowment of professorships, fellowships and opportunities for research and publication. With the library, the laboratories and the academic buildings of the university, with the beauty of its architecture, the charm of the open country, the academic and national traditions of the place, the infant college is surely endowed by the fairies with all ideal gifts.

Professor West has been charged with exploiting the externals of culture, and it may be that he exhibits a touch of the pedantry that he ridicules. But his article in *The Century* is broad and sympathetic; his plans and ideals

DESIGN FOR THE GRADUATE COLLEGE OF PRINCETON UNIVERSITY.



GROUND PLAN OF THE BUILDINGS OF PRINCETON UNIVERSITY, showing the situation of the Graduate College.

are both fine and possible. It is not desirable for students to sleep in dark closets and eat at cheap boarding-houses, or for professors to live in hidden little flats and wash the dishes. Beauty and dignity are as far removed from extravagant luxury as from squalor. Professor West justly says:

Three elements compose the graduate college. Foremost is a body of first-rate professors, to be added to others now in the faculty, interesting men, scholars of high power, eminent in their subjects, and able to waken young men. Do we need to say this is the capital A in the alphabet? If so, let it be said again and underscored, because it would be absurd to say anything else. The second element is a company of students of high ability. . . . The third element is the buildings, the material home wherein this community shall find the realization of its desires.

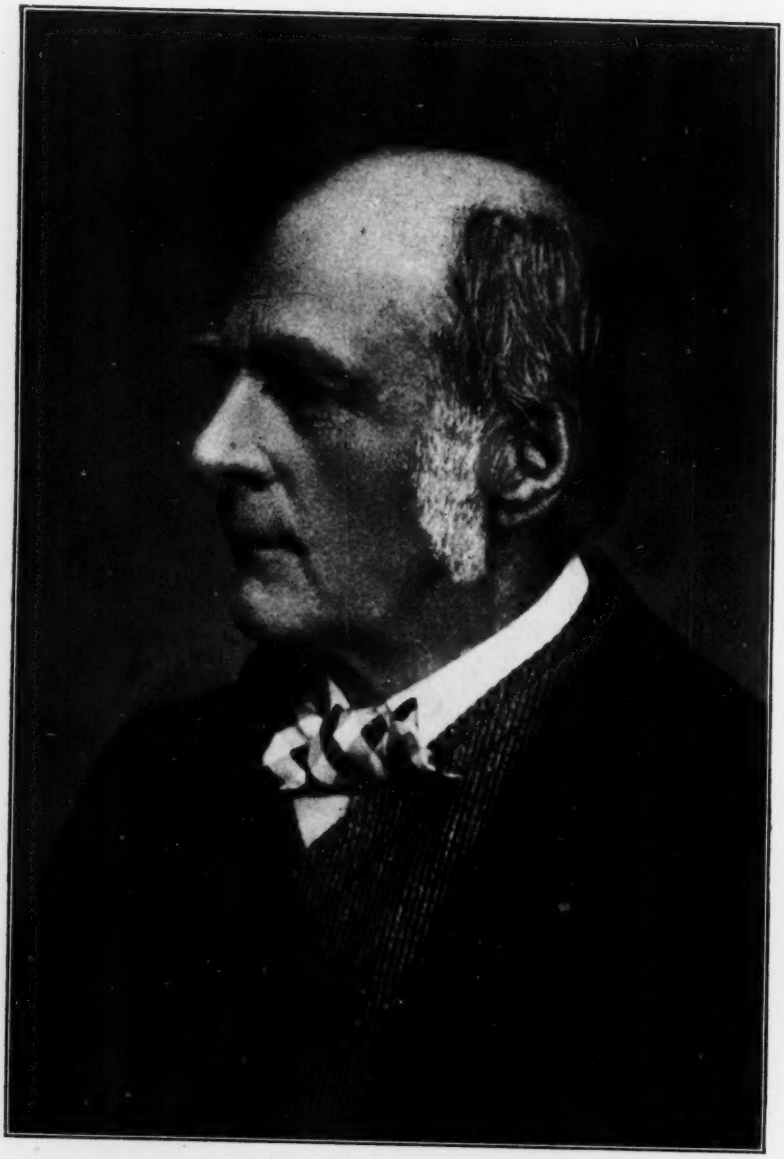
He also writes:

The truth at the heart of this history is that a university is a community, and a community made up of teachers and learners, an actual *respublica litteraria* (to quote an old name for the University of Cambridge), and that in this established and continuing society lies the safety of learning as a self-perpetuating force and the promise of learning as a usable force in the world.

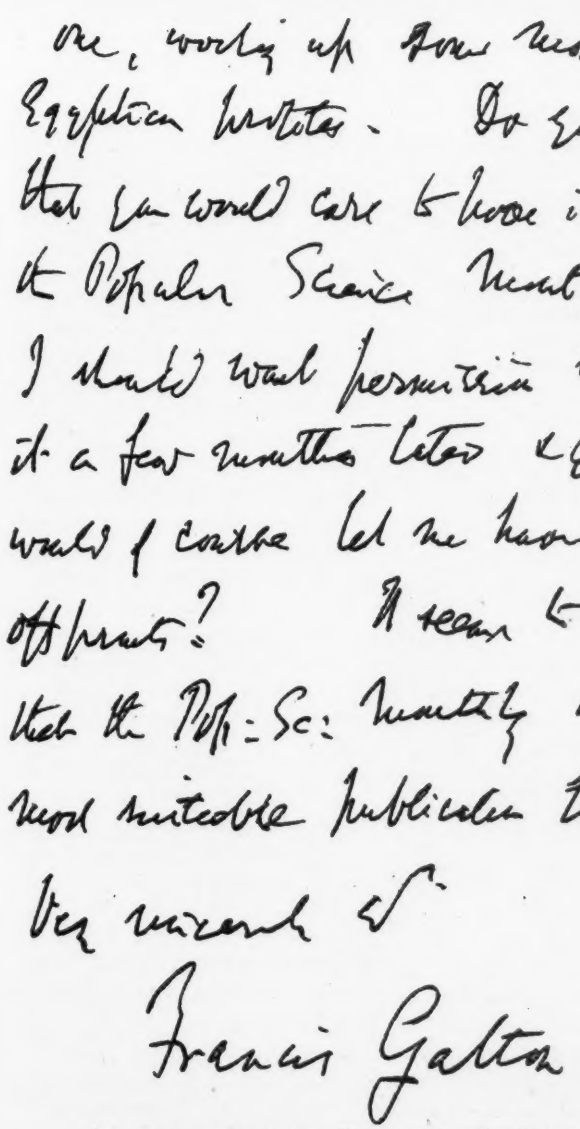
FRANCIS GALTON

FRANCIS GALTON is now dead at the age of nearly eighty-nine years. One more of the great men who gave distinction to the Victorian era has been lost from the small surviving group which in science includes Hooker, now ninety-four years old, Wallace, eighty-nine years old, and Lister, eighty-four years old. In the generation a decade younger there are eminent men still living—Avebury, Rayleigh, Crookes, Roscoe, Geikie and other men of science—and perhaps Great Britain better than any other nation retains the fertility for the production of genius. It may indeed be that the men active in our own day are no less able than those of the nineteenth century; that remains for the next generation to decide. For us, however, these men—Darwin, Kelvin and the great company of leaders in science and letters of the Victorian era—are as giants whose stature we can not reach.

Galton published in 1909 a volume entitled "Memories of my Life," which gives a characteristic and charming account of his varied work and experiences. He was of Quaker descent,



SIR FRANCIS GALTON.



PART OF AN AUTOGRAPH LETTER FROM SIR FRANCIS GALTON,
written in his eighty-ninth year.

and, as is fitting, a member of a distinguished family. The tenets of his grandfather did not prevent him from making a large fortune by the sale of arms in time of war; he wrote about birds and was skilled in statistics. One of his grandsons was Sir Douglas Galton, the eminent engineer. On his mother's side Francis Galton was a grandson of Erasmus Darwin and a half cousin of Charles Darwin. His wife also belonged to a distinguished family—she was the daughter of the dean of Peterborough and the sister of the master of Trinity College; it is the irony of fate that they have left no lines of descent.

It is not needful to review here Gal-

ton's remarkable contributions to science, nor would it be possible to do so. At first sight his work seems to be disconnected; but it represents a normal evolution and has one fundamental basis, namely, the application of quantitative methods to phenomena theretofore outside their control. Beginning with geographical explorations and by the inevitable nature of the man improvements in the conditions under which such explorations are carried forward, he next took up the unstable phenomena of meteorology, devising the graphic method of the weather chart and inventing new instruments. But he soon passed to the still more complicated phenomena of biology, anthropology and psychology. Here his genius touched many subjects. Mental imagery, composite photographs and fingerprints are familiar to all. His great contribution is the study of human heredity by exact methods and its application to the improvement of the race. Galton's word "eugenics" may be soiled by ignoble use; but his work is one of the most original creations of pure science and at the same time one of its most important applications—so great indeed that Galton's body may some day be taken from the quiet churchyard where it lies to be placed beside Darwin and Kelvin in Westminster Abbey.

Galton united certain characteristics which the disciples of George Fox seem to have bred into their blood with the traits which those who knew Charles Darwin found in him. A few days before his death the present writer had the privilege of presenting his name for honorary membership in an academy of sciences to succeed William James. These two men are the greatest whom he has known. James possessed the more complicated personality; but they had certain common traits—a combination of perfect aristocracy with complete democracy, directness, kindliness, generosity and nobility beyond all measure. It has been said that eugenics is futile because it can not define its end. But the answer is simple—we want men like William James and Francis Galton.

SCIENTIFIC ITEMS

WE record with regret the deaths of Professor Leonard Parker Kinnicutt, director of the department of chemistry in the Worcester Polytechnic Institute; of Dr. Edward Gameliel Janeway, professor of medicine and dean of the University and Bellevue Hospital Medical College, and of Dr. Willibald A. Nagel, professor of physiology at Rostock.

SIR JOSEPH LARMOR, Lucasian professor of mathematics at Cambridge University and secretary of the Royal Society, has accepted an invitation to become the unionist candidate for the vacancy in the parliametary representation of Cambridge University.—Dr. W. K. Röntgen, professor of physics at Munich, and Dr. Ewald Hering, professor of physiology at Leipzig, have been appointed knights of the Prussian order pour le mérite. Dr. Gustav Retzius, formerly professor of anatomy at Stockholm, has been appointed a foreign knight of this order.—Dr. Samuel G. Dixon, professor of hygiene in the University of Pennsylvania, and Dr. George Wharton Pepper, professor of law, have been elected trustees of the university.

IT was announced on January 20 that Mr. Andrew Carnegie had added $10,000,000 to the endowment fund of the Carnegie Institution of Washington. The institution was established in 1902 with a gift of $10,000,000, and Mr. Carnegie recently added $2,000,000. These gifts consist of preferred bonds of the Steel Corporation bearing five per cent. interest and their market value is considerably above their par value. Mr. Carnegie's gifts to public purposes now amount to about $200,000,000.